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M E M O I R S  
 OF THE  
**GEOLOGICAL SURVEY**  
 OF  
**G R E A T B R I T A I N**  
 AND OF THE  
**MUSEUM OF PRACTICAL GEOLOGY.**

THE GEOLOGY OF  
 PARTS OF BERKSHIRE AND HAMPSHIRE.  
 (SHEET 12.)

BY  
 HENRY W. BRISTOW, F.G.S., GEOLOGIST,  
 AND  
 WILLIAM WHITAKER, B.A., F.G.S., ASSISTANT-GEOLOGIST.

LISTS OF FOSSILS, BY ROBERT ETHERIDGE, F.R.S.E., F.G.S.

PUBLISHED BY ORDER OF THE LORDS COMMISSIONERS OF HER MAJESTY'S TREASURY.

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## N O T I C E.

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THE Map (12) to which this Memoir refers was published in 1860, and the Memoir itself passed through the press in 1861.

The Cretaceous lines were mapped by Mr. Bristow and Mr. Aveline; and the Eocene formations by these gentlemen, Mr. Whitaker, and the late Mr. Richard Trench, whose early death in India is a loss to geological science, for his work was full of promise.

Excepting outliers, the most westerly part of the Eocene strata of the London Basin lies in this district; and here, as in Sheet 13, to the north, all the subdivisions of these beds have been adopted from those established by Mr. Prestwich.

The descriptive part of the Memoir is chiefly by Mr. Bristow, a smaller part of the field-work of the district having been executed by Mr. Whitaker. Both have availed themselves of notes, furnished by their colleagues; and all the Fossils, excepting those from the Alluvium of the Kennett, have been determined and catalogued by Mr. Etheridge.

A. C. RAMSAY,  
Local Director for Great Britain.

Geological Survey Office,  
January 6, 1862.

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## GEOLOGY OF PARTS OF BERKSHIRE AND HAMPSHIRE. (MAP 12).

### CHAPTER I.

#### PHYSICAL FEATURES.

THE present Map (No. 12.) comprises an area of 675 square miles, and includes the southern part of Berkshire, North Hampshire, and a small portion of East Wiltshire.

The chief towns included in this district are Hungerford and Newbury in Berkshire ; and Andover, Basingstoke, Odham, Alton, and Alresford in Hampshire.

The principal river is the Kennet, which springing in Marlborough Downs enters the Map near its north-west corner, on the north side of the town of Hungerford. Thence it runs nearly in an easterly direction, being frequently divided into smaller streams, which again unite with the main channel, past Avington, Kintbury,\* Newbury, Thatcham, and Aldermaston. Opposite the latter place it follows a north-easterly course, and again crosses the northern margin of the Map about a mile beyond Sulhamstead Bannister, ultimately falling into the Thames a little below the town of Reading. The river Kennet produces a great variety of fish, amongst which the trout and eels have long been celebrated for their size and flavour :—

“ The Kennet swift, for silver eels renown'd ;  
The Loddon slow, with verdant alders crown'd. ”

*Pope's Windsor Forest.*

Large numbers of crawfish are also caught in it.

Along the river Kennet, between Hungerford and Reading (a distance of about twenty-five miles), there extends a valuable tract of water-meadows, producing much grass, which is sometimes made into hay, and at other times depastured with sheep and cattle.

The Kennet and Avon Canal, which is 44 feet broad, and the branch of the Great Western Railway from Reading to Hungerford, as well as the old turnpike-road between those places, follow the course of the valley of the Kennet, and run nearly parallel with the river.

The river Lambourn, a tributary of the Kennet, enters the northern edge of the Map, and after passing Donnington Grove falls into the main stream about a mile below Newbury. This river, also, produces great numbers of fish ; but the trout of the Lambourn are of a paler colour and not so much esteemed as those of the Kennet. The Lambourn is celebrated in consequence of the belief which was formerly entertained of its being fuller in the summer than in the winter, when it was said to be sometimes even lost altogether. There appears to be no real foundation for this story, which may, perhaps, have originated in the circumstance of the river maintaining a nearly equal flow throughout the year, and not varying much either in summer or winter.

The river Loddon (the subject of Pope's fable of *Lodona*) rises in the Chalk, near Basingstoke, and runs in an easterly direction to Old Basing, where it changes its course and flows in a N.N.E. direction,

\* Anciently called *Cheneteberie* and *Kennetbury*, of which latter word its present name is a corruption.

emerging from the Map exactly at its north-eastern corner, and ultimately joining the Thames near Twyford, in East Berkshire.

The small river Emborne, spelt indifferently Auburn, Auborne, Anborn, or Embourn, rises at West Woodhay, and in little more than a mile becomes the boundary between Berkshire and Hampshire as far as Hide End Mill, when it changes its course from an easterly to a N.E. direction, and falls into the Kennet a little below Wasing.

The source of the river Test, celebrated for its trout and eels, is in Ash Park, about a mile and a half east of Overton, and nearly in the centre of the Map. It pursues a south-westerly course past Laverstock and Whitchurch, and soon after passing Tufton it is joined by a small stream which rises near Hurstbourne Tarrant and flows in a south-easterly course by Hurstbourne Priors. At Kitecombe Bridge, beyond Shirwell, it receives the river Anton, which rises at Amport about a mile beyond Monkton on the western edge of the Map, and from that point the united streams flow in a southerly direction past Stockbridge and Romsey, and ultimately discharge themselves into the Southampton Water at Redbridge.

The Itchen rises in the hills round Alresford. Thence the river runs in a westerly direction along the southern border of the Map, past the Worthys to Winchester, whence it flows by the side of the canal and railway to the Southampton Water, where it enters the sea.

The village of Selbourne is on a stream or burn which runs from Nore Hill to the Wey.

"At each end of the village, which runs from south-east to north-west, arises a small rivulet: that at the north-west end frequently fails; but the other is a fine perennial spring, little influenced by drought or wet seasons, called Well-head.\* This breaks out of some high grounds adjoining to Nore Hill, a noble chalk promontory, remarkable for sending forth two streams into two different seas. The one to the south becomes a branch of the Arun, running to Arundel, and so falling into the British Channel; the other to the north. The Selborne stream makes one branch of the Wey; and, meeting the Blackdown stream at Hedgeleigh, and the Alton and Farnham stream at Tilford-bridge, swells into a considerable river, navigable at Godalming; from whence it passes to Guildford, and so into the Thames at Weybridge; and thus at the Nore into the German Ocean."†

There are two other canals besides the Kennet and Avon Canal already mentioned; one between Andover and Stockbridge in the valley of the Test, and the other from Basingstoke to Odiham and Winchfield.

The following is a list of the formations which enter into the structure of the district, arranged according to their ages:—

#### GEOLOGICAL FORMATIONS.

##### Post-TERTIARY.

Post-Pliocene - - - Gravel, Brick-earth, and Alluvium.

##### TERTIARY.

Eocene	- {	Middle -	- {	Bracklesham Beds.
		Lower -	- {	Lower Bagshot Sands and Clays.
		- {	London Clay.	
		- {	Woolwich and Reading Beds. (Plastic Clay).	

\* This spring produced, September 14, 1781, after a severe hot summer, and a preceding dry spring and winter, nine gallons of water in a minute, which is 540 in an hour, and 12,960, or 216 hogsheads, in twenty-four hours, or one natural day. At this time many of the wells failed, and all the ponds in the vales were dry."

† White's Natural History of Selborne, Letter I.

## SECONDARY.

Cretaceous Series.	Upper Series.	-	Chalk.
		-	Upper Greensand. Gault.
	Lower	-	Lower Greensand.

The formations are treated of in the order of their respective ages, the oldest or lowest being described first, and the later or Post-Pliocene deposits last.

The greater part of the district comprised in the Map is occupied by the Cretaceous series, the Tertiary strata occurring chiefly at the northern portion in a kind of narrow triangular trough or hollow in the Chalk. The apex of this triangle is situated at the north-western margin of the map between two and three miles south of Hungerford, on the west; while the two sides extend in a nearly easterly direction to Sulhamstead House on the north, and to Odham on the south, the northern side being bounded for the greater distance by the River Kennet, and the southern side by the high range of Chalk hills or downs.

These two great groups of Chalk and Tertiary strata give rise to and are characterized by scenery of a widely marked diversity of appearance, which can nowhere so well be seen at a glance as from the tops of some of the Chalk Downs between Inkpen and Highclere. From these lofty heights the eye commands, on a clear day, a view over a wide extent of beautiful scenery in all directions.

Lying, as it were, at the feet of the spectator, and extending in a northerly direction from the base of the bare and steep escarpment of the Chalk Downs, is a tract of country for the most part highly cultivated, well-timbered, and luxuriant; studded with villages and hamlets, and diversified by numerous small streams and rivulets. The northern edge of this fertile and low lying tract is bounded by the silvery thread which marks the flow of the river Kennet, on the other side of which the ground rises again with a southerly slope, as the Chalk emerges from beneath the overlying strata composing the district between it and the spectator.

The district between the northern edge of the Map and the Kennet is also well wooded and cultivated where the Lower Tertiary Beds occur, but on the whole it presents to the eye a less luxuriant appearance than the intermediate tract.

Turning now in an opposite direction and looking towards the south, the eye ranges over a broad and undulating landscape, composed, for the most part, of broad turf-covered hills with bold rounded sides and deep waterless valleys (both, as a general rule, bare of trees) and either in a state of nature or only under cultivation here and there. Such is the general aspect of the Lower Chalk, but stretching away into the distance is a more gently undulating tract, based on the Upper Chalk, whose valleys, well watered by streams and rivers, and adorned with noble trees, give rise to scenery of a totally opposite kind.

The wide open nature of the Chalk landscape, even when placed under cultivation, may be noticed by the traveller on the South-Western Railway between Basingstoke and Winchester, between which places (as is the case more or less throughout the entire Chalk district) the population is comparatively scarce, the villages and towns following the courses of the rivers and streams.

The comparatively small areas occupied by the two inliers of Upper Greensand of Shalbourn and Kingsclere, as well as that at the south-eastern corner of the Map are distinguished by their general fertility and varied scenery. These, however, will be fully described further on, and need not be more particularly noticed here.

## CHAPTER II.

## CRETACEOUS SERIES.

## LOWER GREENSAND.

“ In the small space occupied by this formation at the south-eastern corner of the Map there is no large section. The sand is seen in a few places, consisting of loose brownish-yellow sand, with much false bedding, streaked with peroxide of iron, and containing here and there laminæ of light grey clay. Good sections showing these characters may be seen a little beyond the limits of this Map, namely, in the road-cuttings at Kingsley (Sheet 8), 2 miles to the eastward of East Worldham, and in a large sandpit at Greatham (Sheet 9),  $2\frac{1}{2}$  miles south-east from the village of Selbourne; all that is seen here belongs to the uppermost division of the Lower Greensand or the Folkestone Beds.

“ The area occupied by these beds at the surface rises gently to the eastward from the Gault plain. The curved line which marks the out-crop of their junction with the Gault shows a gradual change in strike, which is also indicated by the course taken by the other formations.”

## GAULT.

“ This is a stiff blue clay from its junction with the Lower Greensand, of which no actual section is here exposed, up to near the top, where the beds are marly, partaking of the character of the formation above. The ground occupied by the Gault is for the most part flat, but rises somewhat towards the escarpment of the Upper Greensand, where the slope thus made is covered with fallen masses of the higher formation. It is still a good deal covered with oak, for which in former times it was celebrated.”\*

“ As the parish ” of Selborne “ still inclines down towards Woolmer Forest, “ at the juncture of the clays and sand, the soil becomes a wet, sandy loam, “ remarkable for timber, and infamous for roads. The oaks of Temple and “ Blackmoor stand high in the estimation of purveyors, and have furnished “ much naval timber.”†

The Gault soil is called “ *black land*, ” by the agriculturists of the district. In its natural state it is best adapted for pasture; but when thoroughly and deeply drained it is capable of producing the heaviest crops of wheat, beans, clover, hops, &c.

*Coprolites*, and, amongst them, small *Ammonites*, in an entire state, are found in the Gault of the district comprised in the south-eastern corner of the Map. It has been observed by Dr. Curtis that the *larger Ammonites* are invariably broken into short pieces.

The railway cutting near Alton has yielded the following fossils from the *Gault*.

<i>Pentacrinus.</i>	
<i>Inoceramus concentricus.</i>	
<i>Arca.</i>	
<i>Serpula.</i>	
<i>Lamna.</i>	

<i>Otodus.</i>	
<i>Ammonites interruptus.</i>	
<i>A. mammillaris.</i>	
<i>A. laetus.</i>	
<i>A. tuberculatus.</i>	

## UPPER GREENSAND.

At the base of the Chalk-slope the “ first bed, rarely visible, of the “ Upper Greensand crops out, and, a little below, the hard rocky beds

\* From the Note-book of Mr. Drew.

† Gilbert White's Natural History of Selborne, Letter I.

“ come to the surface. These occupy a terrace, the small inclination of which nearly corresponds to the dip of the strata, but stretching for a width of a mile and a half or two miles, the summit attains a considerable elevation, and ends in a sudden slope or cliff, so steep that it is impossible to get the ground under cultivation, and it is therefore left covered with wood. A view of this escarpment seen from below is given in Fig. 1. Below the cliff, which may be 40 or 50 feet in

Fig. 1.

Malm Rock Escarpment at Hartley.



“ depth, the softer beds of the Upper Greensand crop out, underlaid by the Gault, a little lower down. In this part of the hill, however, the regular strata are covered by large masses of malm rock that have fallen from the cliff, and carried the kind of soil characteristic of this formation below the geological boundary given in the Map, which marks where the junction of Upper Greensand and Gault lies underneath the tumbled masses.”\*

The whole of this formation comprised in the south-eastern corner of the Map extends from Selbourne † on the south to Lower Froyle. In mineral character and appearance it differs considerably from the corresponding formation in Dorsetshire and the south-west of England, in being more calcareous, and of a much whiter colour. The “malm rock,” in fact, bears so strong resemblance to chalk, especially in the upper part, where it is most calcareous, that it might easily be mistaken on a cursory observation for the lower hard beds of the Chalk itself. By its decomposition it furnishes a greyish-white tenacious soil, celebrated for the luxuriant crops of beans, wheat, and hops which are grown upon it, especially in sheltered situations on the gentle slopes at the foot of the chalk hills. The fertility of this soil is due not only to the presence of calcareous matter in the rock, but also to the soluble silica which enters into the composition of some of its beds.

The per-cent of soluble silica varies from 5 to about 70 per cent., or somewhat more, the highest per-cent yet obtained being from a layer about ten feet thick and fifteen feet below the firestone, where from 70 to 75 per cent. may be procured. From this point through the firestone, rubbly rock, and Chloritic Marl to the Grey Chalk Marl, there is a gradual diminution of soluble silica.

The beds which contain a high per-cent of soluble silica are, according to Mr. Paine, easily recognized by their external and physical characters, being (when dry) remarkably light, of a reddish or fawn colour, and very soft, except in some instances where the silica is associated with carbonate of lime.

\* From the Note-book of Mr. Drew.

† In Gilbert White's Natural History the name is spelt Selborne. For the sake of convenience, the mode of spelling adopted by the Ordnance surveyors will be adhered to in the text of this Memoir.

The proportion of calcareous matter in the Upper Greensand is stated by Sir R. I. Murchison\* to vary from 19 or 20 per cent. in the beds of Hawley Slip to 34 per cent. in the compact and cherty ragstones, which occur in the malm rock.

The *malm* of the agriculturists is the soft, brown rubbly rock intervening between the Gault and the harder beds in the upper part of the series. The harder uppermost beds of sandstone constitute the true *freestone*.

The following is an analysis of the soft brown rock immediately above the Gault, by Messrs. Way and Paine :—

	Per cent.
Combined water and a little organic matter	4.15
Soluble in dilute acids, 57.10 :—	
Silicic acid (silica)	46.28
Carbonic acid	none
Sulphuric acid	trace
Phosphoric acid	trace
Chlorine	none
Lime	0.26
Magnesia	0.07
Potash	0.79
Soda	0.43
Protoxide and peroxide of iron	6.12
Alumina	3.15
Insoluble in acids, 38.75 :—	
Lime	2.91
Magnesia	traces
Potash	1.51
Soda	0.60
Alumina, with a little oxide of iron	14.20
Silicic acid (silica) and sand	19.53
	<hr/> 100.00

Gilbert White, in his *Natural History of Selborne*, states that “to the north-east” of the village “is a kind of white land, neither chalk nor clay, neither fit for pasture nor for the plough, yet kindly for hops, which root deep into the freestone, and have their poles and wood for charcoal growing just at hand. This white soil produces the brightest hops.”—Letter I.

Under the name of *freestone* the malm rock furnishes the common building-stone of the neighbouring district, a purpose for which it is well suited by the whiteness of its tint, the facility with which it admits of being worked, and its durability; for if properly seasoned and placed in the position it originally occupied in the quarry, it weathers well, not scaling off on exposure to the action of the atmosphere.

The harder upper beds are also in great request under the name of *freestone*. Gilbert White gives a very good description of the Upper Green Sandstone of the present district in his fourth letter. He there states that,—

“This stone is in great request for hearth-stones, and the beds of ovens; and in lining of lime-kilns it turns to good account, for the workmen use sandy loam instead of mortar; the sand of which fluxes, and runs, by the intense

\* See “Geological Sketch of the North-western Extremity of Sussex, and the adjoining Parts of Hants and Surrey,” Trans. Geol. Soc. Lond., 2nd series, vol. ii. p. 107.

† See a Paper “On the Silica Strata of the Lower Chalk,” by J. Thomas Way and J. M. Paine, Journ. Roy. Agricul. Soc. of Eng., vol. xiv. p. 225.

heat, and so cases over the whole face of the kiln with a strong vitrified coat like glass, that it is well preserved from injuries of weather, and endures thirty or forty years. . . . On the ground abroad this fire-stone will not succeed for pavements, because . . . the rain tears the slabs to pieces."

Associated with the malm rock are occasional beds of blue ragstone, which from their hardness, resist the action of rain and frost, and are very durable. They afford excellent materials for pitching courtyards and stables, for building dry walls against banks, for mending roads, &c. ; but as they do not admit of being worked to a smooth face, they are not so well adapted for building purposes as the beds of freestone.

There is a curious custom practised by the stone-masons of this part of the country. They chip off small pieces of flint about the size of the head of a large nail, which they stick into the wet mortar, along the joints of the freestone. This is probably a very old custom, and is noticed by Gilbert White, who, writing in 1789, remarks, "that " this embellishment carries an odd appearance, and has occasioned " strangers sometimes to ask us pleasantly,—' whether we fastened our " 'walls together with tenpenny nails? "

Occasionally the beds of Upper Greensand are stained yellow or of a rusty colour by iron ; and friable nodules of iron oxide are sometimes also met with, which have resulted from the decomposition of pyrites.

The highly calcareous nature of the malm rock is proved by the manner in which the beech (a tree which is generally supposed to thrive best upon a chalky soil) flourishes upon it, growing as well where the ground is steep as on the Chalk. Although the trees attain to a large size on the freestone, the quality of timber they produce is inferior, being what workmen call *shaky*, and so brittle as often to fall to pieces in sawing.

The long narrow strips of wood growing on the precipitous slopes of the hills, are called *hangs* or *hangers* in this district, in consequence of the way in which they seem to hang upon the steep hill-sides.

One of these hangers is situated on the Chalk immediately behind and overhanging the village of Selbourne on the western side, and another of greater extent, marked Milkwell Wood on the Map, occupies the position of the lower escarpment of the Upper Greensand, immediately adjoining its junction with the Gault. The surface of the ground along the boundary of these two formations is very irregular and broken, for the springs thrown out by the Gault render the clays of that formation so unctuous and slippery as to produce a tendency on the part of the overlying beds to founder and slide over it, especially after seasons of more than ordinary wetness. This is especially observable in the east side of the hanger marked Milkwell Wood on the Map, where extensive founderings of the higher beds have occurred in this manner nearly a century ago, the effects of which can be clearly traced in the tumbled and uneven surface of the ground on either side of the road from West Worldham to Milkwell.

An account of this remarkable landslip may be introduced here, as it will serve to illustrate subsidences of a similar kind and in similar strata of frequent occurrence in many places along the cretaceous escarpments ; amongst others, on the sea-coast at Lyme Regis, in Dorsetshire, and along the entire extent of what is commonly called the Undercliff on the south side of the Isle of Wight.

In each of these cases the causes that have produced the effects have been the same ; the superincumbent strata having been undermined by the springs thrown out by the impermeable clay of the Gault

on which they are based, and having been rendered besides more than usually heavy by the water with which they are saturated after extraordinarily heavy rain-falls, a point is attained when the cohesion of the rock-mass is overcome by its own weight. It consequently gives way; the impetus with which it falls causing it to slide forwards in the direction of least resistance, over the unctuous clay of the underlying formation, for greater or less distances, dependent upon the weight of the foundered mass and the nature of the surface of the ground it passes over.

The effect produced by landslips of this kind is so well described by Gilbert White in his account of the great fall which took place at Hawkley, as to render it worth giving in full, notwithstanding the erroneous opinion entertained by the writer of the ground having "gone down in a perpendicular direction,"—which is sufficiently disproved by his description of the subsequent appearance of the surface.

"When I was a boy, I used to read, with astonishment and implicit assent, accounts in Baker's *Chronicle* of walking hills and travelling mountains.

\* \* \* \* \*

"But, when I came to consider better, I began to suspect that, though our hills may never have journeyed far, yet that the ends of many of them have slipped and fallen away at distant periods, leaving the cliffs bare and abrupt. This seems to have been the case with Nore and Whetham Hills, and especially with the ridge between Harteley Park and Ward-le-ham,\* where the ground has slid into vast swellings and furrows, and lies still in such romantic confusion as cannot be accounted for from any other cause. A strange event, that happened not long since, justifies our suspicions; which, though it befell not within the limits of this parish, yet as it was within the hundred of Selborne, and as the circumstances were singular, may fairly claim a place in a work of this nature.

"The months of January and February, in the year 1774, were remarkable for great melting snows and vast gluts of rain, so that, by the end of the latter month, the land-springs, or levants, began to prevail, and to be near as high as in the memorable winter of 1764. The beginning of March also went on in the same tenor, when, in the night between the 8th and 9th of that month, a considerable part of the great woody hanger at Hawkley was torn from its place, and fell down, leaving a high freestone cliff naked and bare, and resembling the steep side of a chalk pit. It appears that this huge fragment, being, perhaps, sapped and undermined by waters, foundered, and was ingulfed, going down in a perpendicular direction; for a gate, which stood in the field on the top of the hill, after sinking with its posts for thirty or forty feet, remained in so true and upright a position, as to open and shut with great exactness, just as in its first situation. Several oaks also are still standing, and in a state of vegetation, after taking the same desperate leap. That great part of this prodigious mass was absorbed in some gulf below, is plain also from the inclining ground at the bottom of the hill, which is free and unencumbered, but would have been buried in heaps of rubbish, had the fragment parted and fallen forward. About a hundred yards from the foot of this hanging coppice, stood a cottage by the side of a lane; and two hundred yards lower, on the other side of the lane, was a farmhouse, in which lived a labourer and his family; and just by, a stout new barn. The cottage was inhabited by an old woman and her son, and his wife. These people, in the evening, which was very dark and tempestuous, observed that the brick floors of their kitchens began to heave and part, and that the walls seemed to open, and the roofs to crack; but they all agree that no tremor of the ground, indicating an earthquake, was ever felt, only that the wind continued to make a most tremendous roaring in the woods and hangers. The miserable inhabitants, not daring to go to bed, remained in the utmost solicitude and confusion, expecting every moment to be buried under the ruins of their shattered edifices. When daylight came, they were at leisure to con-

\* Spelt Worldham on the Map.

template the devastations of the night. They then found that a deep rift, or chasm, had opened under their houses, and torn them, as it were, in two, and that one end of the barn had suffered in a similar manner: that a pond near the cottage had undergone a strange reverse, becoming deep at the shallow end, and so *vice versa*: that many large oaks were removed out of their perpendicular, some thrown down, and some fallen into the heads of neighbouring trees; and that a gate was thrust forward, with its hedge, full six feet, so as to require a new track to be made to it. From the foot of the cliff, the general course of the ground, which is pasture, inclines in a moderate descent for half a mile, and is interspersed with some hillocks, which were rifted in every direction, as well towards the great woody hanger as from it. In the first pasture the deep clefts began, and, running across the lane and under the buildings, made such vast shelves that the road was impassable for some time; and so over to an arable field on the other side, which was strangely torn and disordered. The second pasture field, being more soft and springy, was protruded forward without many fissures in the turf, which was raised in long ridges resembling graves, lying at right angles to the motion. At the bottom of this enclosure, the soil and turf rose many feet against the bodies of some oaks that obstructed their farther course, and terminated this awful commotion.

"The perpendicular height of the precipice, in general, is twenty-three yards; the length of the lapse, or slip, as seen from the fields below, one hundred and eighty-one: and a partial fall, concealed in the coppice, extends seventy yards more: so that the total length of this fragment that fell was two hundred and fifty-one yards. About fifty acres of land suffered from this violent convulsion; two houses were entirely destroyed; one end of a new barn was left in ruins, the walls being cracked through the very stones that composed them; a hanging coppice was changed to a naked rock; and some grass grounds and an arable field so broken and rifted by the chasms, as to be rendered, for a time, neither fit for the plough nor safe for pasturage, till considerable labour and expense had been bestowed in levelling the surface, and filling in the gaping fissures."\*

The Upper Greensand, as is well known, affords a copious supply of excellent water. The wells at Selbourne are described by Gilbert White, on an average, to run to about sixty-three feet, and when sunk to that depth seldom to fail, "producing a fine limpid water, soft to the taste and much commended by those who drink the pure element, but which does not lather well with soap."

Plentiful springs are thrown out at the surface of the ground by the upper beds of this formation, and also by the underlying Gault.

The beds contain *Pectens* and other organic remains common to the formation in other localities, and large *Nautili* are found in the rock at Froyle. Fossils are not, however, of frequent occurrence, and the most ready mode of obtaining them is from the quarrymen, who generally save what they find in breaking up the stone. A fine collection of fossils from the Upper Greensand and the other rocks in the neighbourhood of Alton has been made by Mr. William Curtis and deposited by him in the Museum of that town, which is also indebted to his persevering industry and scientific attainments for the greater part of the natural history collections it contains.

This formation may be conveniently studied in numerous quarries and deep road-cuttings which occur in the area occupied by it, in the south-eastern corner of the Map. This is especially the case in the neighbourhood of Binstead, in the lane from West Worldham to Wils-ham, and in the lanes between and near Norton Farm and Selbourne. In the lane from the latter village to Oakwood, it contains a bed of hard ragstone, nine inches thick, and with a dip of  $3^{\circ}$  or  $4^{\circ}$  in a direction  $40^{\circ}$  west of south. Beyond Norton Farm, at the intersection of

\* The Natural History of Selborne, by the late Rev. Gilbert White, M.A., Letter LXXXVII.

the lanes, the malm rock makes its appearance in the hollow roadway and watercourse, with a bed of hard, cherty, blue ragstone about a foot thick, dipping  $20^{\circ}$  south of west at an angle of  $6^{\circ}$ .

Between Bonham and Froyle the telegraph posts and the wooden bridge across the railway are placed upon malm rock.

Two patches of Upper Greensand are shown in the north-western corner of this Map ; one near Kingsclere, and the other, including the villages of Ham and Shalbourn, about four miles south of Hungerford.

*Inlier of Shalbourn.*—“The Upper Greensand round Shalbourn lies in the form of an irregular oval, 3 miles in length from east to west and  $1\frac{1}{2}$  across its broadest part from north to south. It is surrounded by escarpments of Chalk, the highest of which is on the southern borders of the Greensand. The occurrence of this inlier is caused by a continuation of the anticlinal curve of the Vale of Pewsey, the Chalk having been removed by denudation. (Fig. 6, p. 29). The axis of this anticlinal appears to run much nearer to the north boundary than to the south, for while the beds of Upper Greensand and Chalk on the north side are inclined to the north-west and north at angles varying from  $5^{\circ}$  to  $20^{\circ}$ , those south of the anticlinal axis are flat or dip at a small angle underneath the Chalk. This is the same in the Vale of Pewsey. The course of the line of axis runs parallel to the northern boundary line. Near Shalbourn its direction is north-east for about half a mile, it then gradually turns and runs east and west nearly to the end, where it bends a little to the south.

No good junction is seen between the chalk and sands, nor is the Chloritic Marl so constant in its occurrence as in the districts represented on Sheets 14 and 36 of the map of the Geological Survey. At the bottom of the Chalk the beds get hard, and pass downwards into whitish siliceous strata like the Malm Rock, and these again into sand ; but there is no section exposed to show the actual passage of this hard white siliceous rock into the sands below. The sands resemble those which form the chief part of the Upper Greensand of Wiltshire, being composed of greyish and yellowish-brown sand with green and black specks, and with beds of irregular blocks of hard grit. Sections of it are to be seen at Shalbourn and Ham. At the former place they dip at an angle of  $5^{\circ}$  to the north-west.

The thickness of the Upper Greensand is here uncertain, the lowest beds not being seen. A well at Ham is 45 feet deep, the bottom of which is probably in or near the Gault. Another well sunk through the lower part of the Chalk at Riever, south of Shalbourn, is 152 feet deep. No detailed information of these wells could be obtained.

The hard, siliceous, white rock of the Upper Greensand is seen by the side of the brook on the west side of Shalbourn, also on the roads north and south of them.

Even in those parts of the area where the strata of Greensand are not seen their general dips may be inferred by those of the Chalk that surrounds it. Thus by the Royal Oak north of Shalbourn the soft Chalk dips north a little west  $20^{\circ}$ , and a little farther to the west the dip is north  $10^{\circ}$ . To the west of West Shalbourn the dip is north-west  $15^{\circ}$ . West of Inkpen Church a soft white chalk, with a few dispersed flints, dips north  $15^{\circ}$ , and south of the church, beds of soft and hard chalk dip  $25^{\circ}$ , in a direction  $10^{\circ}$  E. of N.

*Inlier of Burghclere and Kingsclere.*—Near Kingsclere the manner of occurrence and cause of the reappearance of the Greensand is the same as at Shalbourn and Ham, being, no doubt, a continuation of the same line of elevation, which in this case also has thrown off the strata on the north side at the greater angle. The inlier is  $4\frac{1}{2}$  miles in length

from east to west, and  $1\frac{1}{2}$  from north to south in its broadest part, which is about the centre, the width gradually diminishing towards each end.

The denudation of the curved strata has produced a ridge of some height, running from east to west, about the centre of the Greensand, the slope of the sides according with the dip of the beds, the greatest being on the north. The slope of the Chalk rises immediately at its junction with the sand, and the steepest and greatest elevation is on the south.

The Upper Greensand in the lower beds consists, like that of Shalbourn, of green, yellow, and brown unconsolidated and half consolidated sand, and beds of irregular blocks of hard, compact grit, generally of a light colour, with dark green specks. The upper strata, which may be seen on the road west and north-west of Ham Farm, consists of yellowish white malm rock. West of Ham Farm these beds dip northerly, at an angle of  $5^{\circ}$ , and near the Chalk boundary the dip increases to  $20^{\circ}$ .

No Chloritic Marl is seen at the base of the Chalk, and in the few sections open near the junction, the Chalk is found to be in a soft, marly state. There are no good dips to be obtained along the south boundary either in the Greensand or Chalk. It is probably nearly flat, or else dips south at a small angle.

At Burghclere Farm hard Greensand was noticed, and also in the road cuttings, further east. At the intersection of the four roads dark Greensand occurs, with ragstone above it, separating the former from other sands of a paler green colour, and resembling malm.

In the road to Itchenswell (at the notch in the road on the Map, north of Ham Farm), six feet of hard and white malm appear on the top, with nodular, cherty concretions disseminated through it, and based on pale green, soft, malm-like sand, the whole dipping nearly north at an angle of about  $20^{\circ}$ . The beds are for the most part white, with dark specks, imparting to the whole a dark grey appearance.

Beds of hard compact sandstone may be seen in the turnpike road north-west of Burghclere Farm, and several beds on the road between Kingsclere and Burghclere of hard, compact, grey, gritty sandstone.

South of Burghclere there is a section where the lower beds of the Chalk may be seen passing downwards into hard sandstone.\*

The Malm Rock, near Alton and Selbourne, yields the following fossils, the greater portion of which are in the Museum at Alton.

#### ALTON DISTRICT.—UPPER GREENSAND.

##### ENCHINODERMATA.

*Cardiaster fossarius*, Benett.  
*Ananchetes*.

##### MOLLUSCA.

##### LAMELLIBRANCHIATA MONOMYARIA.

*Pecten asper*, Lam.  
*P. quinquecostatus*, Sow.  
*P. quadricostatus*, Sow.  
*P. orbicularis*, Sow.  
*Exogyra conica*, Sow.  
*Ostrea leviuscula*, Sow.  
*Pinna tetragona*, Sow.  
*Plicatula inflata*, Sow.  
*P. pectinoides*, Sow.  
*Lima elongata*, Sow.  
*Spondylus striatus*, Sow.

##### LAMELLIBRANCHIATA DIMYARIA.

*Arca carinata*, Sow.  
*A. Raulini*, Leym.  
*Unicardium Ringmeriense*, Mant.  
*Pholadomya decussata*, Phil.  
*Myacites mandibula*, Sow.  
*Lithodomus*.  
*Modiola quadrata*, Sow.  
*Thetis*.

##### GASTEROPODA.

*Pleurotomaria Rhodani*, D'Orb.  
*P. perspectiva*, Mant.  
*Solarium ornatum*, Sow.  
*Natica Gentii*, Sow.  
*N. cretacea*.

\* From the Note-book of Mr. Aveline.

<b>CEPHALOPODA.</b> <i>Hanites armatus</i> , Sow. <i>Baculites baculoides</i> , D'Orb. <i>Ammonites rostratus</i> , Sow. <i>A. Catillus</i> , Sow. <i>A. varians</i> , Sow. <i>Nautilus elegans</i> , Sow.	<i>N. pseudo-elegans</i> , D'Orb. <b>Belemnites.</b> <b>PISCES.</b> <i>Saurocephalus.</i> <i>Lamna.</i> <i>Fish-scales.*</i>
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### CHAPTER III.

#### CRETACEOUS SERIES—continued.

##### *Chloritic Marl.*

In the south-east part of the district comprised in this map the Chloritic Marl, which occupies a narrow band at the base of the Chalk Marl, makes its appearance between Farrington and Norton Farm, overlying the malm rock, which there dips  $6^{\circ}$  in a direction  $20^{\circ}$  S. of W., or nearly coincident with the natural slope of the ground. It consists of a marly sand, with specks of green matter, small rounded pebbles, or rather grains of quartz, and a great abundance of fossilized organic remains dispersed through the mass in a very irregular manner.

Phosphate of lime is the principal constituent of these fossils, and it also forms a large proportional ingredient in the marl itself, which, when separated from the fossils, frequently contains from 10 to 15 per cent. of phosphate of lime, and in some cases even more. It has been largely worked at Froyle, and the Chloritic Marl of that locality (exclusive of the fossils) has been found by the analysis of J. Thomas Way, Esq., to contain 14.92 per cent. of phosphate of lime, 25.72 of carbonate of lime, 2.69 of potash, and 0.50 of soda. The land on the Chloritic Marl is remarkable for the extraordinary fertility of the crops that grow upon it, and it is especially suited for corn and hops, which are great consumers of phosphoric acid. The greenest marl is not always the richest, but that which is intermixed with calcareous matter of a white and brown colour affords the largest amount of phosphoric acid. The thickness of this bed is very variable, ranging from a few inches in some places, to as much as ten or even fifteen feet in others.

The Chloritic Marl is well displayed in a malm rock quarry, the situation of which is denoted by a small outlier of Chalk about half a mile north-west of Week Green, where it is affected by a small fault which has caused a downthrow of the beds in a northerly direction of about three feet in amount. The thickness of the Chloritic Marl being also there about three feet, the effect of this disturbance has been to bring the upper part of the Chloritic Marl on the north side of the fault to a level with the bottom of the same bed on the other side.

Mr. Aveline reports that there is no exposure of Chloritic Marl in the inlying masses of Upper Greensand in the valleys of Ham and Kingsclere. A bed of greensand, the equivalent, probably, of the

\* Much information with regard to the localities which have just been described, and "some general conclusions with respect to the origin of certain valleys from the elevation of the strata that now enclose them," will be found in a paper by the Rev. Dr. Buckland, "On the Formation of the Valley of Kingsclere and other Valleys by the Elevation of the Strata that enclose them; and on the Evidences of the original Continuity of the Basins of London and Hampshire."—Trans. Geol. Soc. Lond., 2nd series, vol. ii. p. 118.

Chloritic Marl, is seen in the lane leading from Alton to West Worthing, and also north-west of Selbourne.\*

*Chalk Marl.*

The nature of the Chalk is well displayed in numerous quarries and railway cuttings. Everywhere the soft marly beds, free from flints, and known as Chalk Marl, constitute the lower part of the formation, and furnish a rich soil covering the gentle slopes at the base of the chalk hills, and largely cultivated for the growth of hops in the district comprised in the south-eastern corner of the Map.

The Chalk Marl of the neighbourhood of Alton, according to Mr. Curtis, who is intimately acquainted with the geology of the district, is susceptible of a threefold subdivision. The base of the series is composed of a loose pale grey marl, with beds and concretions of a harder substance, and in some parts it is quite of a blue colour. Above it a white marly chalk, resembling Upper Chalk, is overlaid by a very hard dark green marl, which is quarried at Wilsham. The line of demarcation between the last-mentioned bed and the Lower Chalk is not very distinctly marked. This triple subdivision, however, of the Chalk Marl is altogether local, and does not prevail in other parts of the district.

The Chalk Marl furnishes here, as elsewhere, a rich and fertile soil, producing good hops, wheat, and clover. "To the north-west, north, " and east of the village (of Selbourne) is a range of fair enclosures, " consisting of what is called a white malm, a sort of rotten, or rubble " stone, which, when turned up to the frost and rain, moulders to " pieces, and becomes manure to itself."†

Few fossils occur in this formation, but what few there are strongly resemble those of the same age at Cambridge. The species in the annexed list are in the cases of the Museum at Alton.

<i>Solarium ornatum.</i>	<i>Pecten quinquecostatus.</i>
<i>Pleurotomaria Rhodani.</i>	<i>Spondylus striatus.</i>
<i>Pterocera.</i>	<i>Arca.</i>
<i>Ostrea macroptera.</i>	<i>Iocardia.</i>
<i>Plicatula inflata.</i>	<i>Ammonites laetus.</i>

*Chalk.*

The greater part of the area comprised in the Map is occupied by the Chalk formation.

On the western half of the northern edge of the Map it consists of undulating hills, partially covered with Lower Tertiary strata, and sloping gently towards the south, which is, also, the general direction of the dip, north of the river Kennet. South of the main mass of the Tertiary strata the Chalk rises with the bold and rounded escarpment which is so characteristic of the formation, for the entire distance between Shalbourn at the western margin of the Map and Ewhurst. This fine range of hills owes its importance, between these limits, to the anticlinal that passes through the valleys of Ham and Kingsclere, and has tilted the Chalk on the north side of the line of disturbance into its present highly inclined position. (Fig. 6, p. 29). Inkpen Hill is remarkable for its height, 1,011 feet above the sea-level, being the greatest elevation attained by the Chalk in the south of England.

\* See a Memoir "On the Phosphoric Strata of the Chalk Formation," by J. Mainwaring Paine and J. Thomas Way, Journ. Roy. Agricul. Soc. Eng., vol. ix. p. 75.

† Gilbert White, Letter L.

Between the Chalk range that runs from Shalbourn to Odiham and the southern margin of the Map, the intermediate distance is occupied by minor hills of a more undulating character. These are, in many places, highly cultivated, as in the district west of the river Test; between Andover and Stockbridge the land is, for the most part, uninclosed, and forms bold hills and dry valleys, covered with the close, short herbage which is so well adapted for grazing sheep. The Chalk dips at a considerable angle beneath the Lower Tertiary strata, which trend in a south-easterly direction from Prosperous on the west to Odiham on the east. Between these places the dip of the Chalk is towards the north, but the beds soon arch over again and assume a southerly dip under the influence of the anticlinal axis which traverses the valleys of Ham and Kingsclere, and brings up the Upper Greensand. The Chalk dips at an angle varying from  $10^{\circ}$  to  $30^{\circ}$  between Newton and Ewhurst, but eastward of the latter place the disturbing force appears to have exercised less influence. Although the lowest Eocene beds do not always rest on the uppermost stratum of the Chalk Formation, yet the high inclination of the beds of the western portion of the Map may be sufficient to account for the comparatively small extent of surface occupied by them on the north side of the valleys of Ham and Kingsclere, compared with the range of the same strata to the south of those valleys. In the former case the breadth of the Chalk, including its entire thickness from top to bottom, does not exceed half a mile, and very frequently is not more than a quarter of a mile, while in the latter case it extends for a distance of 13 miles in this map, and still further in that to the south. (Sheet 11).

The fact that in the great disturbances affecting the Tertiary beds in the south of England, the dip is always greater on the northern than on the southern side, has been noticed by Professor John Phillips,\* who observes that "it is exceedingly remarkable that the effect of the "convulsion is such, that in each case the declination of the strata on "the north side is generally very steep, or even vertical, \* \* \* "while on the south side of the Chalk in Hampshire, and the Green-sand and Oolitic groups in the Isles of Wight and Purbeck, are "nearly level or slope gently to the south." An illustration of this is given by the diagram-section at p. 25. "It is further observable that "for a certain length in the middle of each of these ridges the strata "are vertical, or nearly so; on the north side of this length the inclination becomes less and less violent." Thus, "the strata are violently inclined along the line by Highclere in Hampshire (where the Chalk "attains its greatest elevation in England) and at Guildford, but both "westward towards Devizes and eastward towards Kent, the slopes "become gentle."

At the south-eastern corner of the Map the dip of the Chalk is towards the south-west. In that locality the direction of the lower outcrop of the Chalk runs in a north-westerly direction for a distance of about three miles beyond Selbourne, where the trend of the beds changes suddenly to a north-easterly course to Lower Froyle. For this latter distance the upper and lower boundaries of the Chalk rapidly converge as they approach the Hog's Back (sheet No. 8), until at the eastern margin of the Map, the Chalk, which is upwards of twenty miles across at the western margin, is reduced to the width of only four miles.

Of the rivers which have their sources in the area now under notice, the Loddon and the Whitewater are thrown out by the upper part of

\* Manual of Geology (1853), p. 445.

the Chalk, and take a northerly course—while the Anton or Test, originating in lower beds, flows in a contrary direction, nearly due south.

No division has been made in the Map between the Upper and Lower Chalk. The Lower Chalk is comparatively free from flints, which are more plentiful in the Upper Chalk; good specimens of spongiform flints may be obtained from the railway-cuttings at Basingstoke.

The Chalk at Odiham is entirely free from any covering of drift-gravel. A striking instance of this is afforded by the large pit at the south-west end of the town, on the left hand side of the road to South Warnborough, where the Chalk has been quarried, displaying a deep and extensive section of the upper beds. The Chalk is soft and white, and has a gentle inclination towards the north, which is denoted by the darker zones of flint which occur in it. These are not, however, very numerous,—not so much so as is frequently the case in the corresponding beds in other places. The surface is entirely free from Drift or Gravel, except in one or two instances, where the lower parts of potholes of small dimensions make their appearance; in fact, the Chalk seems here to come quite to the surface, the thin covering of whitish soil being apparently formed from the disintegration of the underlying strata by the ordinary action of the weather.

The same appearances are presented by the Chalk for some distance towards the south, but at Uptongrey the summits of the hills are capped with a covering of clay and flint-gravel for a depth of about five or six feet, the sides of the hills being, as usual, free from drift. The occurrence of this kind of clay-drift is strikingly marked by the prevalence of oaks, which are not commonly found growing on a chalky subsoil. Here, however, that tree thrives, as is proved by the fine oak-timber standing on the grounds of Mr. Slater at Uptongrey; while on the opposite range of neighbouring hills, where the Chalk constitutes both soil and subsoil, trees of this kind are either extremely rare or are altogether absent.

The Chalk between Basingstoke and Mitcheldever, and much of that in the immediate neighbourhood of Andover, is also characterised by the absence of drift. Altogether the landscape presents a much more luxuriant and picturesque appearance where the drift occurs, offering a striking contrast to that on the uncovered Chalk, which displays a dry, bare, and open country, comparatively free from the growth of timber. The influence of the drift in modifying the appearance of the landscape is especially remarkable in the valleys which form the main-drainage of the districts they pass through, and which are denoted on the Map by the colour representing alluvium. In these valleys elms and other trees attain a large size, while the luxuriance of the herbage is in striking contrast to the short turf which clothes the dry Chalk downs.

The surface of the Chalk is sometimes worn quite even and smooth, while at other times it is eroded into the irregularly shaped hollows commonly known by the name of potholes. Examples of these are well exhibited in the cuttings of the Salisbury Railway, about half a mile west of Clerken Green, where they occur on both sides of the line on a large scale.

Swallow-holes or hollows connected with fissures in the Chalk through which surface waters which find their way into them are rapidly carried away, or as it were swallowed up, are not unfrequent in this district. One of importance is situated south-west of Kintbury, at the junction of the Chalk and Lower Tertiaries, near the spot denoted by the letter *n* in Wlington. Another is at the south-west corner of the pond at Alresford, which is said to have been formed by Bishop

Lucy in King John's time ; probably most of the water which flows into this large pond escapes through this swallow-hole, which is situated close by its margin. At the time my notice was directed to it, the hole was uncovered, but I was told that sometimes the water drains away so rapidly that the fish have no time to escape, and are left behind on the mud which forms the bed of the pond.

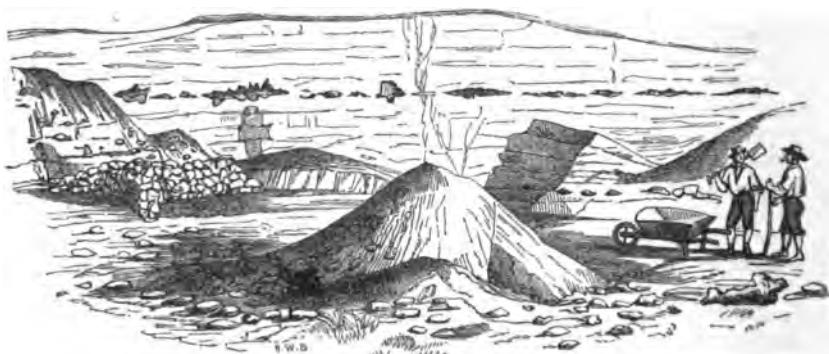
North of Whitchurch, the Chalk, through which the high road is cut, is traversed by joints, in directions south-east and north-west, and  $30^{\circ}$  north of east and south of west ; the beds are nearly horizontal.

The Chalk at the northern edge of Harewood Forest is very soft and white, and is burnt in large quantities for lime. It contains *Belemnites* and other fossils.

In a chalk-pit near Clatford Down Farm curious cavities are apparent in the Chalk, filled with brown sand and tough brown clay ; and, also, an irregular and sometimes interrupted line likewise filled with brown clay. At the first glance, the clay is apparently inter-

Fig. 2.

Section in a Chalk-pit near Clatford Down Farm.



stratified with the Chalk, but a closer examination will explain these deceptive appearances, showing that they are probably to be accounted for on the supposition that a portion of the chalk having been dissolved away, the clay was washed into the vacant space from the surface, taking the place of the chalk which had been removed. For although the chalk situated above the lines of clay bears no appearance of having been broken up and afterwards reconstructed, subsequently to the deposition of the clay, it nevertheless appears, on close examination, to possess somewhat of a brecciated character, the fine lines forming the joints and cracks in the chalk being filled and stained with thin films of brown clay, which has apparently found its way into them from the surface. This is the case even below the patches of clay, where they occur most abundantly, while when the clay is absent, or it only constitutes a thin line, the chalk retains its natural whiteness, both above and below. In this place the chalk is very fine and white, and contains flints irregularly disseminated through it, as well as occasional zones of scattered flints, almost all of which are of spongiform shapes, and sometimes of large dimensions. In this pit joints in the Chalk are filled in two or three instances with flat tabular layers of flint.

Similar tabular layers of flint occur in other places, filling joints in which the silica must have been deposited from solution. They are,

therefore, of later age than the irregularly shaped flints which form zones coincident with the bedding of the Chalk, and are of the same age with it.

South of the pond, about half a mile west of Lower Cranborne Farm, there is a chalk-pit in which there is a waving line of an ochreous yellow colour, the origin of which is probably similar to that of the thin bed of clay already described as occurring at Clatford Farm. It is about six inches thick, where thickest, but sometimes it does not exceed one or two inches. The foreign matter is of less amount here, being only in sufficient quantity to impart a yellowish stain to the Chalk, and to fill up small spaces in it. The chalk in the pit appears to be very loose, which is more especially observable from the yellow band upwards. The underlying portion, which is firmer and more compact, is very white, and contains lines of irregularly shaped flints. The yellow band, and the rest of the overlying chalk, is very loose and fragmentary, showing signs of having been shaken or broken up; and it is owing to that cause, perhaps (the result of its position on the brow of the rising ground to the south) that the effect observed has been produced; the extraneous matter having been derived from the surface, and then having had its further progress downwards stopped by the firmer and more consolidated chalk which forms the lower part of the section. The upper part of the chalk above the yellow band may, according to this view, be regarded as a sort of talus.

A small inlying patch of Chalk is exposed in the lane leading from the "Craven Arms" to Hampstead Marshall, owing to the denudation in the valley of the Tertiary strata, in which *Ostrea edulina* is plentiful in the beds which immediately overlie the Chalk in the road-cutting, and the same fossil is also met with in abundance in similar Tertiary strata, in a small chalk-pit nearly half a mile further, in a westerly direction.

By the side of a lane, nearly half a mile south-east of Kintbury Church, there is a chalk-pit, in which a few feet of the bottom-bed of the Woolwich and Reading series may be seen overlying the Chalk.

There is a large consumption of Chalk in this district for lime-burning, and, in its native state, as a top dressing for the land, which last is now a common mode of applying it as a manure, even in cases where the subsoil itself is chalk. Some of the beds of Chalk, as, for example, those of Asp Mill, furnish an hydraulic lime.

Chalk is also made into whiting at Kintbury, and sent by canal thence, in considerable quantities, both in its raw and manufactured state to Bristol, where it is consigned to the oil- and colour-men.

The whiting is prepared by grinding the soft Upper Chalk, dug on the spot, to a fine pulp with water, and allowing the whole to flow into a series of tanks or reservoirs connected with each other. The sediment which falls to the bottom of these tanks is formed into cakes and then dried under sheds in the open air, in which state it is ready for the market.

At Kintbury there are five manufacturers of whiting, one of whom makes about 600 tons per annum, the others about 300 tons each, making a total of about 1,800 tons. Formerly it used to fetch 30s. per ton, but now it only sells for 8s.

Blocks of unmanufactured chalk are also sold to the same customers, but to a less amount, perhaps 400 tons per annum altogether. The chalk when dug is dressed so as to remove any ferruginous stains from the outer portions of the mass, and is then put away to dry. It is sold at the same price as whiting, fetching 8s. per ton.

The sum of 880*l.* is annually made at the little village of Kintbury by the sale of chalk to districts in which it does not occur, the trade in this article being greatly facilitated by the economical mode of transmission by canal direct to Bristol.

About 30,000 tons of chalk are annually consumed in the part of Hampshire comprised in the southern portion of the Map, details of which will be found at pages 168 and 169 of the Mineral Statistics of Great Britain and Ireland, Part II. for 1858.\* The chalk is used in the form of lime, both for building and agricultural purposes, while the harder beds are used for buildings, locally, in all parts of the county. It is sold in large pieces at from 3*s.* to 5*s.* per load in its rough state; and at 9*s.* the cubic yard when burned into lime.

The Chalk at Itchenswell is soft and like Chalk Marl; it is burned for lime. The Lower Chalk dips 30° in a northerly direction, as also is the case with the Upper Chalk, which is seen underlying the lowest Tertiary strata at the pits worked for chalk and brick-making south of Cow House Farm.

A very abundant spring of water bursts out from the surface of the ground in the Vicarage-garden on the east side of the high road at Itchenswell, and forms at its source a small rivulet. It originates, probably, in some flexure of the Chalk, which causes the water to find a way to the surface in the valley, that runs nearly parallel with the road, at the junction of the Chalk with the lower beds of the Woolwich and Reading Series.

*Turrilites*, with their syphons, are found in the Chalk Marl at Neatham, and *Hippurites* are met with in the Lower Chalk both at that place and at Froyle. Large *Ammonites*, sometimes fourteen or sixteen inches in diameter, are very common in the Chalk in the neighbourhood of Selbourne. Those found in the Chalk Marl fall to pieces on exposure to rain and frost, for which reason they were supposed by Gilbert White, (who wrote at a time when the bearings of fossil evidence on geological questions was not understood,) to be seemingly "a very recent production."† *Nautili* of large dimensions are sometimes obtained in the chalk-pit at the north-west end of the Hanger.

*Echini* and other fossils are abundant in a large pit marked near the eastern margin of the Map, where the Upper Chalk dips nearly in a direction due north, at an angle of 3°.

Hops are grown on the Upper Chalk at Long Sutton, and at the north end of the village of Well, close to the junction with the Lower Tertiary Beds. These localities are the most northerly limits of the district comprised in Map 12, where that plant is cultivated.

Although not visible at the surface, a portion of the Map has been coloured as Chalk at Newbury and for more than a mile to the westward, indications of a substratum of Chalk having been found in digging the foundations for the chimney at the bone-mill, rather more than half a mile from the town in a westerly direction. I was told by the man who dug the well there, that after sinking through about twelve feet of gravel, clay was met with containing lumps of chalk, and also solid soft chalk.

Besides the undulations in a north and south direction, and the minor transverse undulations affecting it in like manner from west to east, the Chalk is comparatively free from disturbance. One fault of small amount has been already noticed in the description of the Upper Greensand, as being visible in a quarry north-west of Week Green.

\* By Robert Hunt, F.R.S., Keeper of Mining Records.

† See his 3rd Letter.

Other trifling disturbances are observable at Whitchurch, in the road-cutting, which forms a mural escarpment on the north side of the road to Overton. The beds of chalk, with zones of black flint, roll slightly, with a general dip of 1° eastward, and are affected by a fault, on the west of which the beds are thrown down about two feet. Four chains further east another fault throws the beds down six feet on the east. Although no division of the Chalk into Upper and Lower is attempted in the text, there is sufficient Palaeontological evidence to give separate lists of Fossils, here appended, on the authority of Mr. Etheridge, who examined the collections at Alton, &c.

## ALTON DISTRICT—LOWER CHALK.

## PROTOZOA.

*Spongia*, in flints.  
*Cliona Mantelli*, Wetherell.

## ECHINODERMATA.

*Ananchites subglobosus*, Leske.  
*Discoidea cylindrica*, Lam.  
*D. subculus*, Leske.  
*Cardiaster*.

## BRACIOPODA.

*Rhynchonella Mantelliana*, Sow.

## RUDISTES.

*Radiolites Mortoni*, Mant.

## MOLLUSCA.

LAMELLIBRANCHIATA  
MONOMYARIA.  
*Exogyra conica*, Sow.  
*Pecten Beaveri*, Sow.  
*P. quadricostatus*, Sow.  
*P. concentricus*, Woodw.  
*P. orbicularis*, Sow.  
*Plicatula inflata*, Sow.  
*Ostrea frons*, Park.  
*O. vesicularis*, Lam.  
*O. frons (carinata)*, Park.  
*Inoceramus Cuvieri*, Sow.  
*I. mytiloides*, Mant.  
*I. latus*, Mant.

## PROTOZOA.

*Choanites Königii*, Mant.  
*Ventriculites radiatus*, Mant.

## ECHINODERMATA.

*Cidaris vesiculosus*, Goldf.  
*C. sceptifera*, Mant.  
*C. perornata*, Forbes.  
*Micraster cor-anguinum*, Leske.  
*Ananchites ovatus*, Leske.  
*Galerites albo-gularis*, Lam.  
*Pentacrinus*.

## BRACIOPODA.

*Terebratula semiglobosa*, Sow.  
*T. carnea*, Sow.  
*Rhynchonella octoplicata*, Sow.  
*R. plicatilis*, Sow.

## LAMELLIBRANCHIATA DIMYARIA.

*Unicardium Ringmeriense*, Mant.  
*Arca Mailliана*.  
*Cardita tenuicosta*, Sow.

## GASTEROPODA.

*Cirrus*.  
*Dentalium ellipticum*, Sow.  
*Avellana cassis*, D'Orb.  
*Natica cretacea*.  
*Solarium ornatum*, Sow.  
*Pleurotomaria perspectiva*, Mant.

## CEPHALOPODA.

*Ammonites navicularis*, Mant.  
*A. Rothomagensis*, Brong.  
*A. varians*, Sow.  
*A. falcatus*, Mant.  
*A. Mantelli*, Sow.  
*A. Coupei*, Brong.  
*A. splendens*, Sow.  
*Nautilus Deslongchampianus*, D'Orb.  
*N. elegans*, Sow.  
*N. pseudo-elegans*, D'Orb.  
*Baculites baculoides*, D'Orb.  
*Hamites armatus*, Sow.  
*Turrilites tuberculatus*, Bosc.  
*T. Scheuchzerianus (undulatus)*, Bosc.  
*T. costatus*, Lam.  
*Belemnitella plena*, Blainv.

## UPPER CHALK.

## MOLLUSCA.

LAMELLIBRANCHIATA  
MONOMYARIA.

*Ostrea vesicularis*, Lam.  
*Inoceramus Cuvieri*, Sow.  
*I. Lamarckii*, Park.  
*Spondylus latus*, Sow.  
*Lima Spinosus*, Sow.  
*L. Hopperi*, Sow.  
*L. elongata*, Sow.

LAMELLIBRANCHIATA DIMYARIA.  
*Teredo amphisbena*, Goldf.

GASTEROPODA.  
*Pleurotomaria perspectiva*, Mant.

## PISCES.

*Dercetis elongatus*, Ag.  
*Otodus appendiculatus*, Ag.

## CHAPTER IV.

## LOWER EOCENE STRATA.

THE main mass of the Tertiary Beds comprised in this Map constitutes their extreme westerly limit in the London Basin. It occupies a trough or synclinal in the Chalk, forming a triangular area, the apex of which, corresponding to the lower part of the synclinal curve, terminates on the ground between Hungerford and Shalbourn. The northern and shorter side of this triangular area commences south of the former town, about a mile and a half north-east of Shalbourn, and pursues a sinuous course in a direction nearly east and west, following the irregularities of the contours of the ground to Hampstead Marshall, where it terminates at the river Kennet, nearly opposite Benham. From that point the base of the Tertiary Series runs nearly parallel with the Reading and Hungerford Railway to Newbury, on the west side of which the Chalk altogether disappears beneath the thick deposit of gravel-drift which covers the lower grounds on either side of the valley of the Kennet.

On the southern side of the mass the Tertiary Beds follow a more regular and unbroken outline in a south-easterly direction, at the foot of the Chalk Downs, through Inkpen, and East Woodhay, towards Highclere, about half a mile west of which place they take a more easterly course, and after passing through Itchenwell, Kingsclere, Sherborne St. John, Chinharn, Old Basing, and Odiham, reach the eastern margin of the Map, south of Dogmersfield House.

In this latter part of their course, on the south side of the mass, the Woolwich and Reading Series occupies only a narrow tract between the Chalk and the London Clay, in consequence of the great inclination of the strata to the north.

H. W. BRISTOW.

## WOOLWICH AND READING BEDS.

*Main Mass—North of the Kennet.*

The small patch of the Reading Beds north of Shaw, and the larger one extending from Brick-kiln Wood southwards to that village, are not outliers, but parts of the main mass, with the rest of which they are connected in the district to the north (Map 13). Along the road up the hill a quarter of a mile east of Shaw Church, a little of the bottom-bed may be seen lying irregularly on the Chalk.

Eastward of the above the Tertiary Beds come on in force, and quite cover up the Chalk. In a pit just north of Yates' Farm the beds shown are pale blue, green, and brown and red mottled clay, over 16 feet of sand, mostly white. At Shaw Kiln, east of the village, the two pits give a section from the London Clay down to the Chalk. In the upper pit the following beds may be seen:—

		FEET
London Clay	- { Brown Clay passing into the "Basement-bed :" —brownish sandy clay, with a little ironstone, containing casts of shells ; at the base is a bed of flint pebbles, some very large.	About 10
Reading Beds	- { Variously coloured mottled plastic clays, with a little sand - - - - -	About 25

The lower pit continues the section, the top bed being the same as the bottom one in the upper pit:—

Reading Beds	White and light-coloured sands, with a little clay; yellow at the base Bottom-bed:—dark bluish-grey shaly clay, with green sand, pebbles, and oyster shells; at the base some green-coated angular flints	FEET
		About 13
	Chalk with flints; with long tubular holes, formed by boring molluscs, and filled with the green sand of the Bottom-Bed, irregularly penetrating the uppermost foot or so.	Over 12

Mr. Prestwich has given more detailed measurements of this section,\* showing the Reading Beds to be about 52 feet thick. When the Geological Survey mapped this area the lower part of the upper pit was much hidden by fallen debris, and the beds could not be measured in detail. The junction of the Reading Beds and the Chalk is here very sharp and even, and there are no pipes. The following fossils have been found in the bottom-bed:†—

* <i>Chelonia</i> , bones of.	<i>Tellina</i> .
* <i>Lamna</i> , teeth of.	* <i>Cythere Mulleri</i> .
<i>Ostrea Bellovacina</i> .	* <i>Echinoferm</i> , minute spines of.
<i>Cardium</i> .	* <i>Globulina</i> .

Eastward of Shaw Kiln the Reading Beds are much hidden by the gravel, which, rising from beneath the alluvium of the Kennet, extends for some distance to the north of that river. At Henwick,‡ and in the brickyard about half a mile north of Thatcham, there is yellow, white, and red mottled clay. East of Thatcham the gravel quite hides the Reading Beds.

W. WHITAKER.

#### *South of the Kennet.*

This series is concealed from view on the south side of the river Kennet between Newbury and Enborne by a wide-spread and deep accumulation of drift-gravel. Where, however, the gravel has been sunk through so as to reach the underlying beds, they are found to consist of the sands belonging to the Woolwich and Reading Series. This occurred during the progress of the survey in 1859, when in building some new houses, south of the railway, the wells were dug in greenish sand, yielding a plentiful supply of excellent water. The same beds were observed to underlie the gravel in the railway-cutting, and to serve for the foundations of the new school-houses, then being built close to the first bridge west of the station. At the latter place the greensand was sunk through for a depth of ten feet, when water was obtained from a bed of clay nine inches thick, with rounded pebbles. These sands contain unfailing supplies of excellent water not only at the places mentioned, but, also along the road from Newbury to Thatcham, where wells have been made in them for the purpose of obtaining water for the roads. The wells, which have an average depth of about thirty-five feet, were difficult to make, in consequence of a white sand running in with the water to such a degree as to produce a subsidence of the ground, and the formation of a cavity at the bottom of the well large enough (according to the description of one of the workmen) to turn a horse and cart in.

Another well at Newbury, opposite Mr. Graham's, is thirty-four feet

\* Quart. Journ. Geol. Soc., vol. x. p. 87.

† Those species marked with an asterisk were not found by the Survey; but have been recorded by Mr. Prestwich. The *Cardium* and *Tellina* were found, for the first time, by Mr. Richard Gibbs, the fossil-collector of the Survey.

‡ M.N.W. of Thatcham.

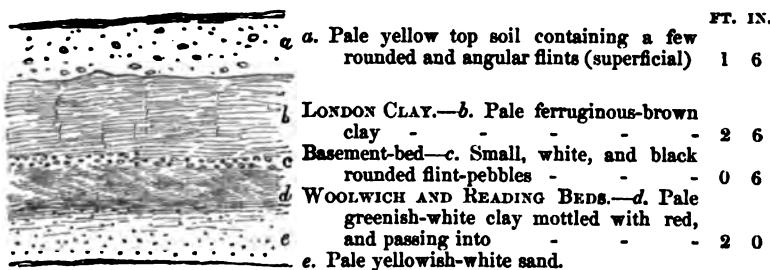
in depth. The upper ten or twelve feet consisted of gravel, resting on twelve or fifteen feet of greenish sand, based upon paler and whiter sand. The oyster-bed a foot in thickness, divided the above sands from the Chalk which occupied the lowest three feet in the well. At Southampton Terrace the wells afforded nearly similar results, the section being first through gravel, while the lowermost six or seven feet consisted of sand, here also becoming paler and then very white towards the bottom.

At Mr. Valpy's brickyards near Skinner's Green, the London Clay, which is the uppermost bed seen, consists of ferruginous-brown, sandy clay, with concretions of iron-ore and particles of green matter disseminated through it. Beneath and resting on brown and green stiff mottled clay, belonging to the Woolwich and Reading Beds, the Basement-bed intervenes, formed of a line of pebbles imbedded in yellow sand. Most of these pebbles are black, but some, both of large and small sizes, are white.

At the intersection of the road from Newbury Wash with that from Skinner's Green and Crockham Heath, the junction of the London Clay with the Woolwich and Reading Beds, as seen in the sand-pit, is as follows, in descending order :—

Fig. 3.

Junction of London Clay and Woolwich and Reading Beds, between Skinner's Green and Crockham Heath.



A similar bed to that described as underlying the pebble-bed appears also to be the uppermost of the Woolwich and Reading Beds in the road from Enborne to the Craven Arms at the intersection of the four-cross roads, where it may be recognized in the road-cutting overlying the sands, which constitute the upper part of the formation. The sand may also be seen in the various road-cuttings, as well as in a pit on the east side of the road from the Craven Arms to Hampstead Marshall.

At another sand-pit about 200 yards south-west of that just described, the junction between the London Clay and Woolwich and Reading Beds is still more sharply defined. Here the former formations rests with the basement-bed on an uneven surface of sand, which exhibits lines of false lamination and occasional ferruginous-brown stains. A hard band of reddish-brown ferruginous sand generally occurs below the basement-bed, and a layer of pipe-clay an inch thick containing angular and rounded flint-pebbles, and replaced towards the basement-bed by a black carbonaceous line, rests on an uneven surface of Reading Sand.

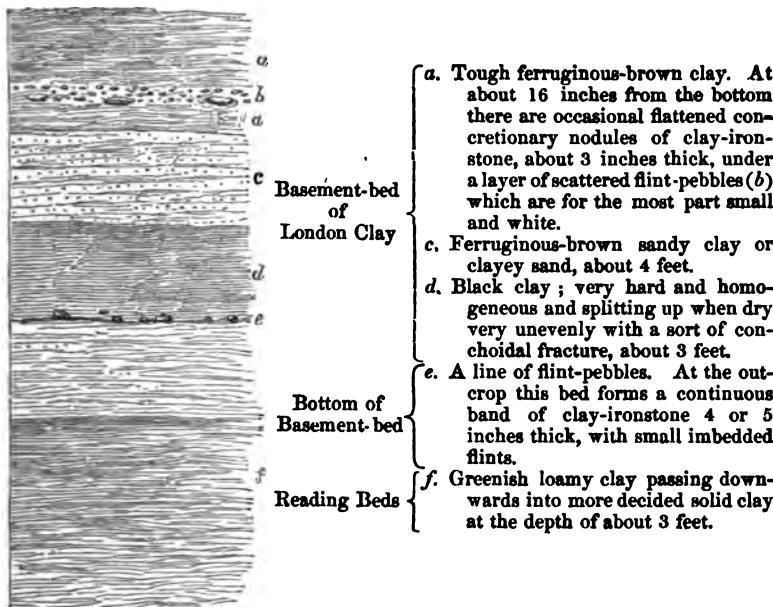
At the north end of Little Common there is a good section of the Woolwich and Reading Beds exhibited in a sand-pit, with hard white mottled clay in the upper part, based on yellow, white, and rose-coloured sands ; the whole presenting a striking resemblance to some of the

variegated sands belonging to the Middle Eocene strata which are seen in the cliffs at Alum Bay.

There is a fair exposure of the junction of the Woolwich and Reading Beds with the London Clay at the brickyard round the northern end of Pebble Hill, where they are worked; the former beds furnishing the tile-clay, and the latter the brick-earth. The section is as follows in the westernmost yard, in descending order:—

Fig. 4.

Junction of London Clay and Woolwich and Reading Beds at Kintbury Brickyard, North of Pebble Hill.



The most westerly point of the main mass of the Tertiary Series, where the Woolwich and Reading Beds are exposed, is in the brick-yard on the outskirts of the wood referred to by Mr. Prestwich as Prosperous Wood, nearly opposite the turnpike on the east side of the road from Hungerford to Shalbourn. The beds here are pale clays at the lower part of the series, and contain subordinate layers of imperfect iron-sandstone and sand from two to three feet thick.

Between Inkpen and the eastern margin of the map beyond Odiham the Woolwich and Reading Series occupies only a narrow zone at the base of the Chalk Downs, in consequence of the high inclination of the beds in a northerly direction. Thus in the lane from East Woodhay to Heath End, there is only a distance of eighty-eight yards from the Chalk, across the Woolwich and Reading Series, the red clays of which appear at sixty-six yards distance, to where London Clay makes its appearance with *Septaria*, containing small fossil shells. Notwithstanding, however, the narrow space they fill, the beds in question are exposed in many more places than might be expected, in consequence of their economical value for sand and tile-clays, for which they are frequently worked.

A good section of the bottom-bed of the Woolwich and Reading Series is laid open in a large chalk-pit, on the west side of the lane leading from the eastern side of Kintbury to Pebble Hill. The surface

of the Chalk appears to be worn quite smooth and even in some parts, while in others it is slightly eroded into inequalities and potholes of the ordinary kind.

The red mottled clays of the Woolwich and Reading Beds are laid open in the brickyards near Kingsmill Farm, and again at the brick-yards about half a mile east of Winchester Lodge, where they are tilted up at an angle of  $30^{\circ}$  and  $35^{\circ}$  respectively. About half a mile west of Itchenstow Church they are again displayed in another brick-yard, where pinkish-purple pipe-clay and white clay with yellow stains, and of white clays in thin beds with white sand above and below, dip about  $30^{\circ}$  towards the north. The upper sands are of a coarser nature than those below.

The following section of the beds here, was noted by Mr. Prestwich when they were more favourably laid open for examination than was the case during the past summer :—

London Clay ; bluish-grey clay, passing into brown, sandy at the base ; a few calcareous concretions and fossils.

Ferruginous sand and iron-sandstone, mixed with green sand and full of rounded flint-pebbles, varying in size from 1 to 14 inches in diameter ; no fossils, except a few teeth of *Lamna*.

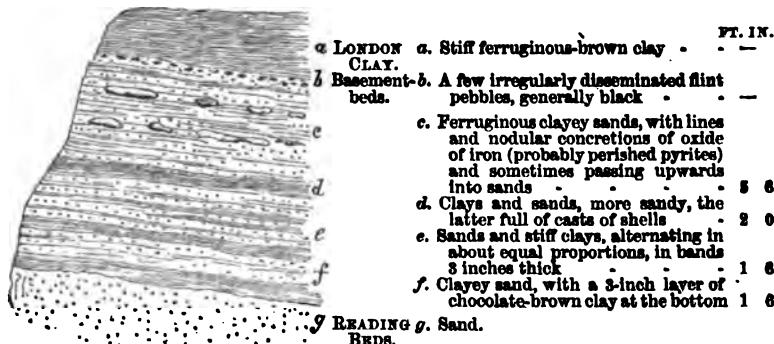
Mottled clay and sands.

North-west of Monks Sherborne Church, near a cottage by the corner of a wood, there are old brick- and tile-yards, where ferruginous-brown sandy clay is seen resting on a red mottled sandy clay, overlying the yellow and white sands which repose on the Chalk. Lower down there are dry bright-yellow sands, with bright carmine streaks and patches.

Between Sherborne St. John and Marnuldell Farm, red mottled clay makes its appearance in the cutting for the road, resting on hard white sand. At the brickyard west of Marnuldell Farm the section is as follows, in descending order :—

Fig. 5.

London Clay and Basement-beds at Sherborne St. John, West of Marnuldell Farm.



At the depth of about fourteen feet from the junction, a band of shells three inches thick is met with in a sandy base, containing *Shark's teeth*, *Pectunculus*, *Cytherea obliqua*, &c., all in a very perished state. Fragments of large *septaria* were also observed scattered about the surface, but none were seen in place.

Hence the red clays pass eastward to Chesham and Old Basing, where they are exposed in pits by the road side, which have been dug for clay. Further onwards on the south side of the railway there are

pits where the sands of the Woolwich and Reading Series have been dug, and the same beds may be traced further eastward by means of old pits, the remains of former workings where the sand was obtained.

The beds of red plastic clay and yellow sands are worked on the north side of the road from Nately to Scures (incorrectly rendered Skewers on the Ordnance Map) in the brickyards belonging to Lord Dorchester.

Throughout the remaining distance between the latter locality and the eastern margin of the Map, the Woolwich and Reading Beds offer no sections of any consequence, but they may be traced by means of the red clays, of which the formation appears almost entirely to consist for the remaining distance.

H. W. BRISTOW.

*Outliers of the London Basin—on the north.*

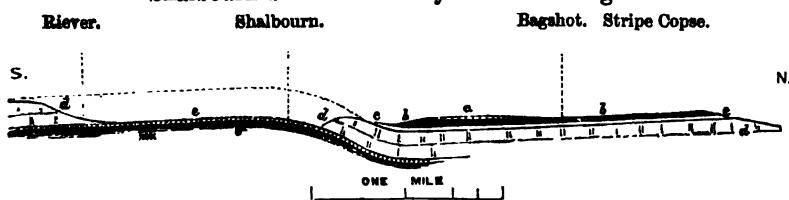
It will be convenient to treat firstly of those outliers north of the great line of flexure, to which are due the Upper Greensand inliers of Ham and Kingsclere, and afterwards of those south of the same.

In the south-eastern part of Cake Wood, west of Hungerford, there is a small patch of sand, filling a basin or hollow in the Chalk.

South-west of the same town there is a large and well-marked outlier of the Reading Beds, capped by London Clay, extending over Stripe Copse, Bagshot, Polstead, Bird's Heath, and Newton. On the south-east, owing to the sharp northward dip of the underlying Cretaceous beds, the outlier is not half a mile distant from the Upper Greensand of Shalbourn; northwards the dip soon decreases, and the Tertiary beds become almost flat, and still further in the same direction it is reversed, being at a small angle to the south. This is shown in fig. 6.

Fig. 6.

Section (along a zigzag line) through the Upper Greensand Inlier of Shalbourn and the Tertiary Outlier of Bagshot.



Scale (vertical and horizontal), an inch to a mile.

a. Pebble-gravel.	d. Chalk.
b. London Clay.	e. Upper Greensand.
c. Woolwich and Reading Beds.	f. Gault.

A small part of this outlier is included in the Map to the west (Sheet 14). There are some good sections in this part, and it will not be out of place to give them here. In a brickyard about three quarters of a mile east of Great Bedwin (Sheet 14) the general section, shown by many small pits, is as follows:—

Basement-bed of the London Clay:—Brown loam and clayey sand, with a line of large black rounded flints at the bottom. (I was told that oyster shells had been found in this bed.) About 7 feet.

Reading Beds

Stiff brown and light blue mottled clay, not plastic, but rather like London Clay; used for making tiles. Lower part more sandy, and full of "lime-wash" or "race" (small roundish calcareous concretions). Many feet thick.
Sand, with a little loam. Sometimes as much as 12 feet.
Very hard clay.
Sand. (Shown in pits lower down.)

The thickness of the beds could not be measured, owing to the small size of the pits ; neither is it certain that the above is a perfect series.

Just south of this brickyard is another, in which I saw (in 1859) a junction of the basement-bed of the London Clay with the sand of the Reading Beds ; not with the clay, as in the former section. Here I saw but one pebble in the basement-bed, whilst in the other brickyard there were many.

At Folly Farm, south-west of the above, and near the edge of Sheet 14, there is a third brickyard. The upper pit is a shallow section in brown and pale blue mottled clay (London Clay). The lower and larger pit gives the following section of the Reading Beds :—

	FEET.
Light brown and grey sandy clay and clayey sand, passing into	About 10 ft. ]
Light bluish-grey clay	5 ft. ]
Bluish-grey or slate-coloured clay, with a bed of brown sand, 4 to 8 inches thick, at top, and three others at intervals	About 5
Light-coloured sand, said to be	2
Beneath which strong blue clay has been found.	

Just south of the farm there is a pit in brown and yellow sand. I was told that 20 feet of sand had been found here above the Chalk ; whilst at the kiln, which is at a higher level than this pit, that rock has been touched 4 feet from the surface, notwithstanding that, according to the general dip of the beds, it should there be deeper. This seems to show some slight disturbance, perhaps an uplift on the north-east.

In the part of this outlier that is included in Sheet 12 there are but few sections ; but the junction of the Reading Beds with the Chalk is in many parts well shown by swallow-holes. In Stripe Copse there are many of these ; there is a line of them along the valley that runs through the middle of the outlier in a north and south direction, from which it is clear that the Chalk is no great distance from the surface in the bottom of that valley ; and there are others near Bird's Heath Farm and Newton.

Of the bottom-bed I saw but few sections in this outlier. In the part in Sheet 14 it seems to be a light green sand ; in that in Sheet 12 I saw nothing but a few inches of light green clay, with green-coated flints.

At the brickyard near Bagshot Farm the section was not very clear. When I saw it (1859) the following beds were to be seen :—

London Clay	Brown clay.
	Basement-bed : Bluish-grey and brown clay, with lines of ironstone, sometimes containing flint pebbles ; at the base a line of ironstone and pebbles, large and small.
Reading Beds	Light brown sand, often clayey.
	Clay found beneath.

In a field south of North Standen Farm there are some large blocks of "pudding-stone," which seem to be in place, and are perhaps hardened masses of the "pebble-beds" of this formation.

Mr. Prestwich gives a general section of the beds near Bagshot,\* according to which the Reading Beds are there between 55 and 60 feet thick. He found the *Ostrea Bellovacina* in the green sand of the bottom-bed.

W.N.W. of Newbury there is a large outlier, forming the high ground above Church Speen and at Stoke Cross, and reaching as far as Wickham, in the Map to the north (Sheet 18), with a breadth of

\* Quart. Journ. Geol. Soc., vol. x. p. 85.

from half a mile to nearly a mile, and a length of about 6 miles (see Memoir illustrating Sheet 13, pp. 32, 50, and 56). Owing to the thick covering of flint gravel on this outlier there are but few sections ; the boundary of the Reading Beds is, however, marked in places by swallow-holes. The small patch of these beds east of Elcot Park is a projecting part of this outlier. In the road-cutting here the bottom-bed is shown. "Just below the Nag's Head, east of Church Speen, " there is a brickyard, the pit in which gives the following general " section :—

Reading Beds	Flint gravel.
	Yellow, white, and red mottled clay.
	Yellow sandy clay.
	Reddish-brown and light blue mottled clay.

" Along the boundary of the Reading Beds from this part to Church Speen, the ground has slipped in many places, and the clays and " sands of that formation have thus fallen down below their true " boundary-line. At the brickyard east of Church Speen the following " beds have been found :—

	FEET
Gravel of angular and rounded flints, irregular, filling hollows in the underlying clays and sands, from a foot to several feet thick.	
Reading Beds	Dark coloured stiff clay, in places reddish, with an admixture of yellow sand.
	Yellow and white sand, with thin beds of light-coloured clay
	Stiff blue clay, with thin layers of ironstone and of yellow sand
	Bottom-bed :—green sand, with an oyster-bed at the base
	About 12
	About 12
	About 6
Chalk.	

" No dependance can be placed on the continuance of the above thicknesses for any distance, nor even on that of the beds themselves, " for they seem to be in wedge-shaped masses. The bottom-bed and " the lower part of the bed overlying it were not to be seen when the " section was noted (1858) ; the information was got from a workman " who had seen the beds down to the Chalk in the pit, and in a well in " the brickyard."\*

The hill on which Donnington Castle stands and the one to the east are formed of the Reading Beds, being parts of a large outlier which runs northwards, by Snelsmore Common, to within a short distance of Chieveley, in Sheet 13 (see Memoir illustrating that Sheet, pp. 34, 50, and 56).

W. WHITAKER.

The two small outliers on either side of Stanham Green, at the north-west corner of the Map, are chiefly yellow sand, which has also been dug near the house at Hungerford Park.

#### *Outliers between the London and Hampshire Basins.*

Sand has been got from the small outlier marked near Conholt House, where the thickness of the Tertiary strata resting on the Chalk must be very trifling. In Harewood Forest there are three outliers, where bricks are made from the red mottled Plastic Clay which underlies the gravel and brickearth forming the upper part of the section ; but the

\* From the Note-book of Mr. Aveline.

thickness of the Eocene Beds is not more than a few feet, and it might almost be doubted if these lowermost beds are really a part of the latter series, or merely drift (brickearth). Apparently, however, some of the lower clay seems to be mottled clay, belonging to the true Woolwich and Reading Series ; it contains rounded pebble-gravel, and has at the bottom large black-coated chalk-flints, which are often found on the irregular surfaces of chalk at the base of the Tertiary formation in the Hampshire Basin.

The nature of these beds will be understood from the annexed fig. 7, sketched from one of the openings made in the small outlier at the south-west corner of Harewood Forest, between Goodworth Clatford and Mount Pleasant. The section there is as follows, in descending order :—

Fig. 7.

Section at S.W. Corner of Harewood Forest.



- a. Loamy top soil, with a few small rounded and angular flints.
- b. A mixture of rounded and small angular flint-gravel, in a reddish-brown clayey base.
- c. Reddish-brown mottled clay, passing into white clay mottled with red, and with an occasional rounded pebble.
- d. Reddish-brown mottled clay, containing carbonaceous matter.
- e. White, pale and yellowish, reddish and brownish clay, much blackened by carbonaceous matter, and very sandy.
- f. Irony-yellow sand ; red in places.

At the north-east corner of Doles' Wood, by Stoke Hill Farm, there is a ferruginous loam dug inside the wood for making bricks. At the depth of about twenty feet a bed of clay three feet thick was pierced, under which there was a layer of flints resting on another bed of loam. The latter was bored into for five feet without any chalk being met with. It was stated by one of the workmen that borings had been made nearly throughout the whole extent of the wood, and that the loam did not extend more than a hundred yards from the pit in any direction, —chiefly towards the north-west.

A narrow outlier of the Woolwich and Reading Series may be traced on the summit of the Chalk Down, south-east of Walbury, by means of the pits that have been dug for the purpose of getting the clay, which was made into bricks and tiles on the spot.

Extending from Sheppwood Coppice, between South Warnborough and Froyle, at the south-east corner of the Map, there is a deep and

extensive accumulation of superficial deposits which might at first sight be mistaken for Lower Tertiary Strata, but which on more careful examination prove to be the brickearth, to be described presently. South of Shaldon, however, there is a small outlier of true Lower Eocene age by the side of the lane to Winhall farm, apparently filling a large pot-hole or hollow in the Chalk for a depth of more than twenty feet. The greater portion of the mass is a white or french-grey sand, similar to that of Windmill Hill, with subordinate white pipe-clays slightly mottled red, which in one place appear to have fallen from the upper part—where also the sands are sometimes of a yellow colour.

At Windmill Hill, on the east side of the road, there are old workings where sand and clay were formerly got for brick-making purposes. The pits being now overgrown with grass, the details of the beds are concealed from view; but it would seem that the sand and clay were not obtained from the same pits. Near the intersection of the roads to Red Hill the sands are well exposed for examination in the pit near the farm-buildings. Here, as is the case at the Shaldon outlier, the sands are of a kind of french-white colour, occasionally assuming a greyish tint in places, owing to the presence of finely divided vegetable matter in a carbonized state, and containing seams and irregular lines of pale ferruginous-coloured sand. The sand itself also assumes a ferruginous tint, and an irregular surface in the upper part, which is covered with a deposit of ferruginous sand and reddish clay, derived, probably, from the red mottled clay of the Woolwich and Reading Beds. Small rounded pebbles of white quartz are occasionally disseminated through the white sands.

There is a large outlier of Lower Tertiary Strata forming the high grounds between Hoydon Common and Swanthorp Farm, which forms a conspicuous feature in the landscape from a considerable distance, in consequence of its elevation and the trees which grow upon the more elevated central portion.

This outlier may be at once recognized as belonging to the Tertiary Series at a distance of many miles by persons accustomed to view scenery with an eye to its geological structure, and to study the intimate relation between the features of a landscape and the geological formation on which it is dependent. Although this outlier covers a considerable area, there are no good sections and but few means afforded of examining the nature of the beds. The prevalence of clays over the area in question is, however, sufficiently evident from the state of the roads, which after wet weather become so muddy as to be almost impassable to persons on foot.

Traces of red clay, belonging to the Reading Series, may be seen towards the lower parts of the beds occasionally, but the general character of the soil appears to be a stiff yellowish clay. Most probably the upper part, forming the crest of the hill (distinguished by the letter i 3), and denoted on the Map by a dotted line, may be London Clay; but in the absence of any fair exposure of the beds, in consequence of the thick covering of wood, it is impossible to speak with absolute certainty on this point.

At the north-west corner there are old pits, now overgrown with grass and brambles, where brickearth appears to have been formerly got. There is also a small opening or two further west, (between Horsdon and Common, at the end of a blind lane leading to a farmhouse, and between a clump of fir trees and a pond,) dug for the purpose of getting sand. The sand, which is yellow, and contains thin beds of ferruginous grit, appears to be lying horizontally, and is probably at or very near the base of the Tertiary Beds.

There are three other small outliers of Woolwich and Reading Beds. One between Doily Wood and Stoke; another on Brick Hill, between Laverstock and Overton; and the third south of East Stratton: at which last bricks and tiles are made from the lower clays and sands.

## CHAPTER V.

### LOWER EOCENE STRATA—*continued.*

#### LONDON CLAY.

##### *Main Mass: South of the Kennet.*

THE London Clay on the south side of the valley of the Kennet occupies a considerable area. It is, however, concealed from view over a large part of the district in question, either by the overlying Lower Bagshot Beds, or by the drift-gravel, which is spread deeply over the surface in many places. The lower beds forming the junction with the Woolwich and Reading Series, and including the basement-bed, are those most frequently displayed. The nature of these, as laid open in the brickyards near Crockham Heath and at Pebble Hill, have been already described, and the entire formation appears to be merely an extension of similar ferruginous, brown, tenacious clays, becoming dark blue or grey at depths too great to be affected by atmospheric influences, and sometimes containing occasional layers of septaria and fossils.

H. W. BRISTOW.

At the brickyard at Woolwich Green, north of Sulhamstead Abbots, there is a large section in brown London Clay, which here contains selenite, and probably fossils. When I saw the section (in September 1860) the *basement-bed* was just cut into at the northern end. It consists of the usual brown loam, and, although but little of it was to be seen, two or three beds of fossils were shown. It also contained a little clayey ironstone and some selenite, which latter I have not noticed in the basement-bed elsewhere. I found the following fossils in this bed here:—

<i>Acteon.</i>	<i>Corbula.</i>
<i>Aporrhais.</i>	<i>Cyprina.</i>
<i>Fusus.</i>	<i>Cytherea obliqua.</i>
<i>Natica glaucooides.</i>	<i>Modiola?</i>
<i>N. sp.</i>	<i>Nucula.</i>
<i>Pleurotoma.</i>	<i>Panopaea?</i>
—	<i>Pectunculus brevirostrum.</i>
<i>Avicula.</i>	<i>P. decussatus.</i>
<i>Cardium</i> (2 species).	<i>Tellina.</i>

For about a mile and a half eastwards from the above the line of junction between the London Clay and the Reading Beds, is also the boundary-line of the valley-gravel. In a cutting along the lower part of the road going up the hill, nearly a mile east of Woolwich Green, the basement-bed, full of fossils, may be seen.

Along the western edge of a wood, not shown on the Map, nearly a mile north of Burghfield, there was (in September 1860) a small shallow section in the basement-bed, showing a shell-bed (*Ostrea*, *Cytherea obliqua*, and *Pectunculus brevirostrum*), pieces of ironstone,

full of casts of *Ditrupa*, (as at Redlands, Reading ; see Memoir illustrating Sheet 13, p. 49,) and blocks of sandstone, sometimes with shells. At one part there were casts of *Pectunculus*, in ironstone, lying loose in brown loam, beneath which was brown sand (probably belonging to the Reading Beds).

The London Clay was shown, in 1857, in a ditch along the by-road, from three quarters of a mile to a mile north-west of Shinfield Church. In it there were concretions of ironstone.

W. WHITAKER.

A well was made in a cottage garden, by the four cross-roads, at Emborne Street, during the summer of 1859, in London Clay, through dark grey clay, with nodules of iron pyrites and septaria, for thirty feet, at which depth small black pebbles were met with, and the beds assumed a more sandy character. The black pebbles encountered here most probably were from the basement-bed of the London Clay. A few fossils were brought up with the clay from the bottom of the well, consisting of *Turritella*, *Neritina*, &c. *Nautilus* accompanied the septaria. At another cottage, a short distance to the westward, the solid clay extended to a depth of fifty or sixty feet, and the bottom of the well reached the greensand, with *Ostrea edulina*, which occurs at the base of the Woolwich and Reading Series.

On the east side of the road, south of the south-east corner of Newbury Cemetery, there was formerly a brickyard (called Eyles'), but the clay (apparently London Clay) was so much mixed up with stone (flints from the drift) that they were obliged to grind the clay to prevent the bricks from flying to pieces in the burning, and this, probably, led to the abandonment of the works. The following is a list of the chief fossils from the London Clay at Eyles' brickyard.\*

<i>Rostellaria</i> (small).	<i>Ditrupa</i> .
<i>Turritella</i> .	<i>Teredina</i> .
<i>Pleurotoma</i> .	<i>Cardium</i> .
<i>Natica</i> .	<i>Pectunculus</i> .
<i>Vermicularia</i> .	

At the western termination of the Tertiary formation, as well as throughout the entire area comprised in Sheet 12, the London Clay, as well as the Woolwich and Reading Series, appears to be of considerably less than its ordinary thickness, seldom exceeding fifty or sixty feet ; in some cases it falls short even of that at its southern outcrop.

The only place, with the exception of Emborne Street, where fossils were found in the London Clay of the district, was in the steep sides of a brook at the southern corner of Kingsclere Common, where they were in tolerable abundance. The beds there consisted of blue clay, weathering brown on exposure, and becoming sandy towards the upper part. In addition to the fossils, consisting chiefly of *Turritella imbricataria*, *Natica glaucooides*, *Corbula pisum*, *Pectunculus brevirostrum*, and *Ditrupa plana*, &c., the clay contained irregularly disseminated nodules of iron pyrites.

The section of the London Clay, as displayed in the brickyard at Chincham, on the railway, about a mile north-west of Old Basing, is as follows, in descending order :—

	FT. IN.
Soil, no gravel	1 0
1. Dark, ferruginous-brown, stiff clay	3 0
2. Occasional small, black, flint-pebbles	3 0

\* T. R. Jones' Lecture on the Geological History of the Vicinity of Newbury, p. 39.

	FT. IN.
3. Paler ferruginous-brown sandy clay, with lines and scattered nodules of good iron-ore towards the lower part	3 6
4. Still paler ferruginous-brown clayey sand, with irregular veins of chocolate-coloured pipeclay, 4 inches thick at 1 foot; another near the base, 3 inches, and small nodules of iron	1 6
5. Clayey sand as before, but more clayey	3 6
6. The same, with a line of perished bivalve-shells on the top and scattered throughout; about 2 ft. 6 in. seen	2 6

These beds, which represent the basement-bed of the London Clay, overlie the mottled red clays of the Woolwich and Reading Series in the adjoining railway-cutting, and contain (according to Mr. Prestwich) patches of—

*Cytherea obliqua.*

*Ditrupa plana.*

*Pectunculus brevirostrum.*

*Natica glaucoidea.*

*Cardium Plumsteadense?*

*Lamna (teeth).*

In a considerable cutting laid open at Cuffell during the construction of the railway from Basingstoke to Reading, a remarkable abundance of *Panopaea* was found “imbedded in the clays in a vertical position, similar to that which the recent species assume in their living habitats at the present day, proving the quiescent deposition of these portions of the strata. The *Pholadomya* and *Pinna*, the latter of which attains an unusually large size at Cuffell, exhibits also there the same peculiarity of position.”\*

Nearly sixty species of shells were collected by Mr. Edward Cole in this locality, during the progress of the railway. The following list of the fossils found there, revised by Professor Morris and Mr. Edwards, is given on the authority of Mr. Prestwich :—

*Ditrupa plana*, Sow.  
*Serpula trilineata*, Sow.  
*Ostrea*.  
*Pecten cornutus*, Sow.  
*Pinna affinis*, Sow.  
*Arca*.  
*Cardium nitens*, Sow.  
*Corbula*.  
*Cultellus affinis*, Sow.  
*Cyprina planata*.  
*Modiola depressa*.  
*M. subcarinata*.  
*Pectunculus brevirostrum*.  
*Venus*.  
*Cytherea obliqua*, Desh.  
*Nucula amygdaloides*, Sow.  
*N. lunulata*, Nyst.  
*Panopaea intermedia*, Sow.  
*Pholadomya margaritacea*, Sow.  
*P. Dixonii*, Sow.  
*P. virgulosa*, Sow.  
*Teredo antenata*, Sow.  
*Bulla*.  
*Cancellaria leviuscula*, Sow.  
*Cassidaria striata*, Sow.  
*Cerithium*.

*Dentalium nitens*, Sow.  
*Fusus tuberosus*, Sow.  
*F. angusticostatus?* Mell.  
*F. carinella*, Sow.  
*F. trilineatus*, Sow.  
*Murex cristatus*, Sow.  
*Natica Hantoniensis*, Sow.  
*N. glaucoidea*, Sow.  
*Pleurotoma rostrata*, Sow.  
*P. elegans*, Mell.  
*Pyurula Smithii*, Sow.  
*P. tricostata*, Desh.  
*Ringicula turgida*, Sow.  
*Rostellaria lucida*, Sow.  
*R. Sowerbii*, Mant.  
*Solarium patulum*, Sow.  
*Scalaria*.  
*Trivia (Cypræa)*.  
*Turritella imbricataria*, Sow.  
*T. sulcifera*, Lam.  
*Typhis muticus*, Sow.  
*Nutilus imperialis*, Sow.  
*N. Sowerbii*, Sow.  
*Lamna elegans*.  
*Myliobates*.

\* See Memoir “On the probable Age of the London Clay, and its Relations to the Hampshire and Paris Tertiary Systems, by J. Prestwich, jun., Esq., F.G.S., &c.,” Quart. Journ. Geol. Soc., vol. iii. p. 369.

A section similar to that at Chingham is seen at the brickyard at Priest Croft, north of Old Basing, and nearly the same beds as those last noticed, are exposed in the pits where the clay is dug. The upper part of the section consists of five feet of reconstructed London Clay, containing, at rare intervals, small white angular flints, and occasionally small rounded black pebbles. At the lower foot, though more numerous and in some few cases larger, these are still very scarce, as is also the case in the upper four feet and in the top soil.

Septaria, some of them crowded with *Modiola* and *Cardium*, and much fossil wood pierced by *Teredo*, occur in the London Clay at Newnham (between the Basingstoke and Winchfield railway-stations) in a dark grey sandy clay, frequently containing numerous small rounded pebbles of black flint.

The following list of the fossils found in this locality is given on the authority of Mr. Prestwich, to whose Memoir on the London Clay the reader is referred for further details in reference to that formation\* :—

*Ditrupa plana*, Sow.  
*Serpula extensa*, Brand.  
*Vermicularia Bognoriensis*, Sow.  
*Terebratula striatella*.  
*Lingula tenuis*.  
*Anomia lineata*, Sow.  
*Avicula media*, Sow.  
*Ostrea flabellula*, Lam.  
*O. cymbula*? Desh.  
*Pinna affinis*, Sow.  
*Cardium nitens*, Sow.  
*C. Plumsteadiense*, Sow.  
*Cyprina planata*, Sow.  
*Cytherea obliqua*, Desh.  
*C. suberycinoides*, Desh.  
*Modiola elegans*, Sow.  
*M. subcarinata*, Sow.  
*Panopaea intermedia*, Sow.  
*Pholadomya margaritacea*, Sow.  
*Solen affinis*, Sow. (*Cultellus*).  
*Teredo antenata*, Sow.  
*Actaeon simulatus*, Sow.

*Ancillaria*.  
*Daphnella junceum*, Sow.  
*Cancellaria leviuscula*, Sow.  
*Cassidaria carinata*, Lam.  
*Fusus bulbiformis*, Lam.  
*F. errans*, Sow.  
*F. tuberosus*, Sow.  
*Globulus depresso*, Sow.  
*Natica glaucooides*, Sow.  
*N. Hantoniensis*, Sow.  
*Pleurotoma rostrata*, Sow.  
*Pseudoliva obtusa*, Sow.  
*Pyrula Smithii*, Sow.  
*Rostellaria Sowerbii*, Mant.  
*R. lucida*, Sow.  
*Ringicula turgida*, Sow.  
*Turritella imbricataria*, Lam.  
*T. sulcifera*, Lam.  
*Voluta elevata*, Sow.  
*Nautilus imperialis*, Sow.  
*Lamnae*, teeth of.

The rounded pebbles in the basement-bed near the junction of the Reading Series with the London Clay are remarkable for their occurrence over a very large area, throughout which they serve as a valuable means of separating the two formations, even in cases where they bear so strong a resemblance to each other, that, in the absence of fossils, it would almost appear, but for the presence of the pebbles, an impossibility to draw a line of demarcation between the two.

The pebbles are irregularly scattered through the sandy clay, which forms the basis of the basement-bed over the district under notice, and although, for the most part of small size, they nevertheless occasionally attain considerable dimensions. A remarkable peculiarity connected with these pebbles is, that although on examination they appear to be in their original compact and perfect condition, yet when struck with a hammer, even a gentle blow, they fall to pieces; being traversed by minute cracks in all directions, dividing the stones into irregular fragments, without, however, completely destroying the adhesion between the fractured surfaces. These surfaces appear to be sometimes coated

\* Quart. Journ. Geol. Soc., vol. iii. p. 371.

with thin films of ferruginous clay or oxide of iron, which have apparently gained admission through the cracks from without.

The greater number of the pebbles are, moreover, black, though some are occasionally coated white externally. No one has yet accounted for the cause of the flints becoming shattered, but it may not be difficult to find a reason why, as a general rule, they are black.

On examining the newly-fractured surfaces of flints fresh from the Chalk they will generally be observed to be black. On exposure to atmospheric influences, as light, heat, and moisture, flint gradually assumes a paler hue, and after a certain time becomes opaque-white or of a pale-greyish colour, as is apparent in old walls or houses which have been built of dressed flints. On a still further exposure to the same influences, flint undergoes an alteration analogous to that experienced by carnelian, which, after it has been exposed to the action of the light and sun for a couple of years, and subsequently heated artificially, exchanges its natural grey colour for the beautiful red with which we are accustomed to associate the name of red carnelian. So, too, in numerous instances, the flints which compose the drift covering the higher levels, and which for an immense period of time have been subjected to atmospheric influences, have frequently lost their original blackness and become of a bright red, doubtless in consequence of their having been exposed during so long an interval. It may, therefore, be supposed that the reason why the flint-pebbles met with in the basement-bed of the London Clay retain their original hue, is owing to their having been covered up by the deposits in which they occur, before they had been exposed long enough to influences the ultimate tendency of which would be to produce an altered appearance;—or in other words, that they experienced only a comparatively brief exposure.

If this be the case, we are led to infer that the interval of time represented by the pebble-bed was of comparatively short duration, and that the pebbles themselves are chalk-flints which have become rounded by attrition in the ordinary manner on the shores of a shallow sea, and that they were covered up by the succeeding deposits before they had been exposed long enough to become bleached on the outside or to have acquired a red colour within.

The locality where the basement-bed of the London Clay appears best developed in our present area is in the neighbourhood of Sulhamstead Abbots and Burghfield, on the south side of the Kennet. North of those places it was well shown in the brickyards between Sulhamstead House and Pingwood, underlying the ferruginous-brown London Clay, which is worked for brickmaking purposes. Several fossils were procured from this interesting and wide-spread deposit by Mr. Whitaker, during the progress of the Geological Survey. (See p. 30.)

In the Transactions of the Geological Society\* it is stated, on the authority of J. Rose, jun., Esq., that a bed of cockle shells was found twelve feet below the surface at Hose Hill, in the parish of Burghfield. The section is described to be, at the place in question, in descending order :

	F E E T
LONDON CLAY.—Blue clay, with many scattered Oysters	about 40
BASEMENT-BED.—Concrete of shells and clay (water)	55
PLASTIC CLAY. { Blue and white clay	-
	Red clay, with occasional sand
	about 35

\* Trans. Geol. Soc., 2nd series, vol. v. p. 129.

*Outliers.*

There is an outlier of London Clay in the district south of the Kennet, at Emborne. In the road from the church to the "Craven Arms" the junction between the London Clay and the Woolwich and Reading Series is shown in the bank forming the road-cutting. The uppermost bed of the latter series consists there, as in many other instances, of a somewhat paler clay than the main mass of the overlying London Clay, and is based upon sand.

H. W. BRISTOW.

On the large outlier of the Reading Beds, south-west of Hungerford, there are two outliers of London Clay. In the western one, which extends from Bird's Heath to Newton, and of which a small part is in the Sheet to the west (14), there are two sections of the basement-bed and one in the London Clay itself (see pp. 25, 26). In the other there is also a section of the basement-bed (see p. 26), and the London Clay may be seen in the road-cutting south of Bagshot. This outlier stretches some way south of Polstead, but its northerly extension in Stripe Copse is doubtful. It was formerly thought to be the most western point at which the London Clay occurs in the London Basin.\* This, however, is not the case; there are four outliers of that formation farther westward—the one just noticed; and, in Sheet 14, a probable one on the top of Castle Hill, a small one just north of Wilton Common (south of Great Bedwin), and another on the hill west of the same village, and three miles from the outlier at Bagshot.

On each of the two hills north of Shaw, near Newbury, there is a small patch of London Clay, the southern ends of an outlier that stretches northwards to Courage Common (Map 13).

The mass of London Clay that extends from Shaw Kiln, where there is a section in this formation showing its basement-bed † (see p. 20), to Weaver's Wood and Upper Henwick, joins on, in the Sheet to the north (13), to the far larger mass on the east. The only section is at the kiln; but the clay is unmistakeably shown in the fields. In the larger eastern mass, on which there is a wide-spread capping of the Bagshot Beds (see p. 36), brown clay may be seen in many places. By the road-side, just west of Coldrop Farm, about a mile and a half east of Thatcham, the brown loam of the basement-bed was found. "On the top of Beenham Hill, south-west of Beenham House, there is a 'brickyard, in which the clay is capped by about 2 feet of gravel.'‡ The boundary-line south-west, south, and north-east of Woolhampton is very doubtful, owing to the great spread of gravel; indeed, it is not unlikely that the London Clay reaches much farther than is shown on the Map; perhaps, occurring under the alluvium and gravel of the Kennet. In this case the area now treated of would not be an outlier, but would form part of the main mass.

W. WHITAKER.

\* Quart. Journ. Geol. Soc., vol. vi. p. 257.

† Mr. T. R. Jones, in his Lecture on the "Geology of Newbury," p. 37, has noted the occurrence of the following fossils in the London Clay here:—Vertebrae of Fish, *Fusus?* *Buccinum?* *Nucula*, *Pectunculus*, *Cardium*, *Panopaea*, *Modiola*.

‡ From the Note-book of Mr. Aveline.

## CHAPTER VI.

## MIDDLE EOCENE STRATA.

## LOWER BAGSHOT BEDS.

RESTING immediately on the tenacious beds of the London Clay are the Middle Eocene strata which have received the title of Lower Bagshot Sands and Clays, from their development in the neighbourhood of Bagshot Heath near London.

The boundary between these two formations presents a very serrated and indented outline, conforming itself to the irregularities of the ground ; the Bagshot Beds, which form the escarpments of the higher grounds, being cut through by numerous combes and valleys down to the London Clay.

The Lower Bagshot Beds may be described as a series of very fine sands and clays, sometimes laminated, sometimes passing downwards from yellow sand into a sandy clay at the lower part, which again merges by a gradual transition into the stiff blue London Clay upon which it rests. "This passage-bed is well exposed at a brick-yard  $1\frac{1}{2}$  miles south-west of Burghfield Church, and at another on the right hand side of the road running in a north-east direction from Mortimer West-end ; also in the railway cutting north-east of Bramley."\*

The boundary between the Lower Bagshot Beds and the London Clay is generally marked by the wet and rushy nature of the ground, in consequence of the water which filters through the permeable sands of the former formation being thrown out at the surface by the clays of the latter.

The line of springs is not, in the absence of other corroborative evidence, to be taken as a safe guide in separating the London Clay from the Bagshot Sands ; for the water contained in the overlying gravel is often thrown out by some of the numerous zones of pipe-clay, which in most instances occur in the Bagshot Sands.

These pipe-clays are sometimes laminated and contain carbonaceous matter, as may be seen at the pits, on the Common, a mile west of Mortimer House.

*Outliers.*

*North of the Kennet.*—There is a large irregular outlier of these beds at the northern margin of the Map, occupying the higher grounds of Hartshill and Bucklebury Common, north of Thatcham. A small part of it extends into the adjoining Map (Sheet 13), and a short notice of the general character of the beds will be found in the Memoir explanatory of that Sheet, at page 53.

Although sections are not numerous in this outlier, partly in consequence of the thick deposit of drift-gravel covering the crests of the hills, there is, nevertheless, a fair exposure of them in a few places. The most favourable spot for examining these beds is at the brickyard, E.N.E. of Thatcham, between Hart's Hill and Bucklebury Common, where they consist of alternations of yellow and white sands with pale blue clay and layers of iron-sandstone.

Bright yellow sands were dug up in making a well close to the northern margin of the Map, and pale yellow sands resembling the ordinary sands of this series are exposed in a pit on the south side

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\* From the Note-book of Mr. Richard Trench.

of the road over Bucklebury Common, opposite Heath Copse. These dry yellow sands pass downwards into coarse, brown, ferruginous sands, forming the passage into London Clay, upon which last the Lower Bagshot Beds repose here, as elsewhere. These passage beds may be seen at Hart's Hill, north-east of Thatcham, and in the road-cutting at the north-east side of Bucklebury Common.

*South of the Kennet.*—The most westerly mass of the Lower Bagshot Beds in this Map is that forming the irregularly shaped outlier extending over Inkpen Common. The nature of the deposits in this locality is displayed in some sand-pits and natural sections at the western extremity of the mass, and again in the shallow openings in the fir plantations, where pale pipe-clays have been dug to the depth of about a yard for supplying some potteries, in the immediate neighbourhood, where a coarse ware is made from them. In the sand-pits at the north-eastern corner of the Common these beds consist of ferruginous, white and yellow sand, with numerous black carbonaceous spots, lines, and patches ; and the details of the section, in descending order, are as follows :—

White, angular, and sub-angular shingle-gravel. The above is a superficial deposit not connected with the Bagshot Series.

1. Black carbonaceous clayey sand, 2 inches.
2. White clay, a good deal spotted with iron ; generally white, but brown in some places and in others crimson ; the whole forming a red mottled clay which at first sight might be mistaken for similar beds belonging to the Woolwich and Reading Series.
3. White and yellowish-white sand acquiring a ferruginous-brown coating on the outer part of the mass.

There is a thin layer of Bagshot Sand forming an outlier at Pebble Hill, between the thick covering of Pebble-gravel, which forms the crest of the hill, and the London Clay. During the progress of the survey of the district in question, although there was no actual exposure of the Bagshot Beds in this locality, their presence was nevertheless inferred by me from a careful study of the ground, and their supposed limits were drawn on the Map, as they are engraved at the present time. On subsequently revisiting the spot, during a tour of inspection with Professor Ramsay, the accuracy of the deduction was proved by means of some deep trenches which had been dug into the Bagshot Sands, for drainage purposes, on the east side of the road, where the gravel had been quarried away. The beds at this point consisted of buff and pale ferruginous-yellow sands, interstratified and alternating with thin seams of pipe-clay.

The boundary of the West Woodhay outlier, about half a mile to the east of that of Inkpen Common, as well as that of North End, in the almost total absence of sections, is very obscure, and cannot be traced with certainty, in consequence of the absence of any marked feature in the ground and the thick deposit of overlying gravel. The only place where the sands are seen is south of Holly Copse, in a small opening by the side of the lane to Woodhay Green near where it is crossed by the little watercourse, and in the lanes at the southern extremity of the last-mentioned outlier.

The beds forming the outlier from Hatt Common to East End are more fully displayed. They may be examined at Bolt Hill and on the west side of the road to East Woodhay, especially in the fields south of Heath End.

The next outlier, which is also much covered with gravel, offers no features worthy of special notice. There are, however, places (chiefly about the central portion of the mass), south of Woolton Hill, where

the beds may be seen ; but the topography of the Map is so different from the ground in consequence of old roads having been altered and new ones made since the district was originally surveyed, that it very frequently requires considerable patience and labour to indentify the exact position of any particular spot.

At the brick-and-tile-yard, near where the four roads meet north-east of Kingsmill Farm, there is a small exposure of the Bagshot Beds showing them to be dipping in a north-easterly direction at an angle of 30°. It is doubtful whether this small mass of Bagshot Beds forms a separate outlier, or whether it is united, for a short distance, to the large outlier which extends in an easterly direction to Earlstone House and Newtown.

An account of the beds at the western side of this large outlier will be given subsequently in the description of the Bracklesham Beds at page 40. Considerable difficulty was, in the first instance, experienced in mapping the boundary between the London Clay and the Lower Bagshot Beds, between Adbury House, Earlston House, and West Street, in consequence of the absence of sections and the occurrence of the brown clay which prevails between Adbury Farm and West Street. This was, in the first instance, mistaken for London Clay, but a closer examination of the ground proved it to be based upon true Bagshot Sand, and to occupy the position of the clay, which occurs in great force further eastwards, and which, (as will be presently explained,) was the source of much perplexity in making the survey of the district around Ramsdell.

The high grounds south of Newbury, between (and comprising) Newbury Wash and Brimpton, consist of a long range of hills from a quarter of a mile to a mile and a quarter wide, and extending for a distance of upwards of six miles in an east and west direction. They consist of Lower Bagshot Beds, subordinate to the thick deposit of flint-drift, which everywhere forms broad and level plains constituting the crests of the hills.

The outline of this outlier is of a very irregular kind. The sands may be traced round the escarpment of the hills, where they occasionally make their appearance from beneath the overlying drift-gravel, the dry surface of which presents a striking contrast to the wet and swampy nature of the ground upon the impermeable London Clay.

The sand is shown in several places, amongst others in a cutting by the side of the road from Sandford, south of the "Old Harrow" Inn. The beds consist there of whitish sand, becoming hard and ferruginous in the upper part, and having an irregular surface covered with drift-gravel, composed of rounded flint, shingle, and subangular flints. There are, also, traces of white pipeclay, and the sand beneath the gravel is sometimes of a red colour.

At the Newbury Union a bed of white pipe-clay, containing the leaves of plants, was found at a depth of thirty feet from the surface. These beds correspond precisely with the pipe-clay deposits of the Isle of Purbeck, which are so rich in vegetable remains, and which there, as well as at Bournemouth, and in the Isle of Wight (at Alum Bay\*), form a part of the Lower Bagshot Beds.

The largest outlier of the district lies between Sulhampstead, Wasing,

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\* See Horizontal Sections, Sheet 47, No. 1, and Vertical Sections, Sheet 25, No. 5.

Ramsdell, and Bramley.\* At the Ramsdell brickyard, yellow and white sands and clays form the uppermost five or six feet of the section, and pass downwards into a sort of ferruginous, pale brown and white clay, not unlike some beds of the London Clay, and used here for making tiles. There is no gravel of any consequence, but a few flints are scattered through the superficial soil for a depth of about nine inches, and also occur sparingly in potholes or pockets.

At the northern end of the brickyard, by the roadside, the beds appear to be more laminated and sandy than is the case on the south side, and a laminated chocolate-coloured clay has been dug for making bricks, from beneath the laminated sands and clays already described as forming the upper part of the section.

This clay, which may be called the Ramsdell Clay, is of great thickness, and is remarkable for the strong resemblance which it bears to the more clayey and ferruginous beds of the London Clay. This resemblance is so great that Mr. Trench, as well as myself, both of whom had considerable experience in surveying the Lower Tertiary Beds, were in the first instance deceived by its appearance, and referred the clay in question to London Clay when making the geological survey of this neighbourhood. It became evident, however, on further examination, that the brown Ramsdell Clay formed a part, in reality, of the Lower Bagshot Series, and that this great development of clay was not confined to our present area, but that it prevailed more or less over other portions of the district. This was proved, beyond the possibility of doubt, by means of the underlying sands of the Lower Bagshot Series, resting upon clay belonging unquestionably to the London Clay formation. On a close examination it was also remarked that the Ramsdell Clay bore a kind of resemblance to the pipeclays of common occurrence in the Bagshot Beds ; and for this reason, probably, it is adapted for making tiles (a purpose for which London Clay is seldom suitable), being an impure or imperfect pipeclay, intermediate in quality between the true Bagshot Pipeclays and the more sandy beds of ordinary London Clay.

The Ramsdell Clay has been sunk through in making a well at the south side of the yard for twenty-seven or twenty-eight feet, at which depth a sandy loam was reached, which yielded a plentiful supply of very good water. It was also seen in a pit at the back of Mr. Kimber's house, where it is ferruginous, very tough, and fit for making tiles. In the process of drying, consequent on exposure to the air, it shrinks and cracks very much in a vertical direction, so that it splits from the face of the cutting in narrow slabs or wedge-shaped masses. The clay contains sandy nodules of iron, resulting from decomposed pyrites, and towards the lower part of the section exposed (where it seems to become more sandy, and to approximate more closely in character to the passage-beds into London Clay), it contains much green matter in the form of minute green specks, as in the London Clay of Alum Bay, in the Isle of Wight. Angular fragments of flint, derived from the superficial drift, have been carried into the clay, and the upper five or six feet appear to have been reconstructed.

On the west side of the road, at the northern end of Little London, bricks are made of pale grey pipeclay five feet in thickness, and passing upwards into four or five feet of french-grey clay, which becomes

\* "Pipe-clays laminated, and containing carbonaceous matter, may be seen at the pits on the Common, a mile west of Mortimer House. A good pipe-clay (not 'laminated') is exposed in a section on Silchester Common, north of Beggar's 'Green.'—From the Note-book of Mr. Richard Trench.

mottled with bright red, owing to the peroxidation of the iron. This latter clay has an irregular surface, and is overlaid by gravel, composed of small, angular, white flints, in a clayey and sandy base. Above all is a hard, dry, sandy wash, which, from its tint of faded green, has seemingly been derived from the Bracklesham Beds, occupying the higher grounds to the northward. This wash, of which a thickness of five feet was exposed, contains a few small white, angular flints and pebbles disseminated through it at rare intervals.

The sand-pits in Pamber Forest, on the east side of the road at Little London, are dug in fine dry white sand, with occasional stains and lines of a pale yellow colour, six feet of which, forming the lower beds exposed, are seen in the pits. Five feet of similar sand, with laminæ and layers of white pipeclay and occasional small nodules of iron, and becoming more clayey towards the upper part, are overlaid by three feet of pale or french-grey sandy pipeclay, with ferruginous stains of a darker colour. Above is a ferruginous-brown weathered clay fifteen inches to two feet thick, containing now and then small patches of fine angular flint-gravel for the most part white, but with here and there a small, rounded black pebble. The top-soil, which is nearly white, and of an average thickness of nine inches to a foot, is of a more sandy nature, and passes into and covers an uneven surface composed of the decomposed clay beneath.

On the west of the high road between Silchester Common and Tadley Common, near where the road is crossed by the county boundary, ferruginous, yellow, clayey sand, was seen, which had been dug up from beneath the drift-gravel in making a well for a new house. Dark grey sandy clay was taken from the bottom of the well precisely similar to that occurring to the south of Penwood. In all probability it in reality belongs to the Bracklesham Beds, and not to the Lower Bagshot Series; but, owing to the thick covering of drift-gravel which covers the surface of the ground far and wide, the absence of fossil evidence, and the great scarcity of good sections, it is not possible to prove the true geological position of the clay in question. Moreover, if it could be satisfactorily proved to be a part of the Bracklesham Series, it would not have been possible to draw any line of demarcation between the Bracklesham and Lower Bagshot Beds, in consequence of the difficulties just alluded to. They have, therefore, both been represented on the Map by one colour in this locality.

A short distance further south, at the brickyards on Tadley Common, ferruginous and pale grey clays, underlying the gravel, form the brick-earth, and rest on a dark grey sandy clay like that taken out of the well. A thickness of ten feet of clay was noticed in the pits here. The gravel consists of eight or ten feet of rounded and subangular shingly flints, closely packed in a sandy matrix. The whole of this deposit is of an extremely irregular nature, and covers a very uneven surface of dry, hard, ferruginous-yellow sand containing false laminations and lines of white pipeclay, covered unconformably in the more easterly part with white pipeclay and ferruginous sand laminated with white pipeclay. All the beds are, however, at this spot very irregular, and apparent dips are not to be depended on.

The other small sand outliers of Holly Hill, Brock's Green, and Catt's Farm, present no features deserving of special notice, and the same may be said of the other minor outliers of Goose Hill and Holt Common. The sands which occur at the south side of Headly Common are based upon white clays, which furnish the material for the bricks that are made there.

There are two outliers of Lower Bagshot Sands south-east of Pamber End and south-west of Beaurepaire House. Both occupy inconsiderable elevations, and consist chiefly of yellow and white sands, sections of which are laid open in the pits where they are dug for building purposes.

On the east side of the Basingstoke and Reading Railway, between Silchester and West End Green, there is a small outlier of Lower Bagshot Sand ; and on the east side of the river Loddon there are no less than seven others.\*

No Ramsdell Clay is found at the outlier of Arborfield Cross, Farley Hill, or Hickfield Heath, but we find it on Rotherwick Hill, and the Newnham outlier is entirely composed of it, with the exception of one or two feet of sand resting on the London Clay.

#### *Main Mass.*

The Ramsdell Clay is also used for brickmaking at the kilns south-west of Hartley Row, where the section was described by the brickmaker to be as follows :—

	FEET
Ramsdell Clay (Lower Bagshot)	- 8
Sand, with iron concretions, and giving out water	- 1
Blue London Clay	"

The two latter strata are not visible, but they were described by the workmen as sand containing bits of iron-mould.—(From the Note-book of Mr. R. Trench.)

## CHAPTER VII.

### MIDDLE EOCENE STRATA—*continued.*

#### BRACKLESHAM (MIDDLE BAGSHOT) BEDS.

THE most westerly of the outliers of Bracklesham Beds occurring in the Map is that cut through by the high road from Newbury to Ivy House.

At the brickyard, situated on this outlier, north of Woodhay Common, the bricks are made of the Bracklesham Clay, and the underlying Bagshot Sand. The upper part of the section there is composed of six or eight feet of ferruginous, angular flint-gravel, beneath which the details of the Bracklesham Beds, which are here about twenty feet thick, are as follows :—

	FEET
1. Ferruginous-brown sands	4
2. Dark brownish-grey, tough laminated clay, weathering something like paper-shales	2
3. Pale grey clay, more sandy than the bed above	6 or 8
4. White and yellow sand, and thinly laminated white pipeclays ; and yellow sands with rounded pebbles, some of which are as large as a fist	10
5. Bright yellow sands of the Lower Bagshot Series.	

\* A line of springs shows the junction of the Bagshot Sands and London Clay, at Farley Hill.

The Bagshot Beds between the eastern side of the district and the river Loddon were surveyed almost entirely by Mr. Richard Trench, who was soon afterwards transferred to the Geological Survey of India. The few notes he left behind relating to the geology of the district have been incorporated in this Memoir.

Further south a well was dug for the supply of water to the new parsonage house, which was being built; and it would appear from the nature of the clay, &c. brought up, that the Bracklesham Beds must be at least forty feet thick by the side of the high-road, the bright yellow sands of the Lower Bagshot Series, noticed in the brickyards further north, not having been met with at that depth. Some of the clay brought up was of a dark brownish-grey colour, and similar to that constituting No. 2 of the preceding section. In it I found what appeared to be a portion of the umbo of *Cardita planicosta*, but the shell was in such a perished and fragmentary state as to render its identification, except by inference from the size and thickness of the portion found, almost impossible.

The Bracklesham Sands were noticed on the south side of the road, under the hedge of the wood, south of Pound Street. The beds there, which form a portion of another outlier, consist of pale, ferruginous-yellow, or tawny sands, containing green grains.

Possibly some of the sands of the outlier of Lower Bagshot Beds, between Sandford and Woolverton, may belong to the Bracklesham Series. On the north side of Woolverton, west of the "Hare and Hounds," Glauconite-sands, perhaps of Bracklesham age, were noticed under the park paling, in the bank through which the road is cut. A few white and black, scattered flint-pebbles occurred at the base of these upper sands, which rested on other sands of a bright orange colour. These last were also hard and somewhat clayey, with white laminae, and most likely formed the uppermost part of the Lower Bagshot Beds.

Beds succeeding them, in descending order, are exposed in a roadside sand-pit about fifty yards further, in an easterly direction. They consist of bright-coloured ferruginous, or orange-yellow sand, and yellow and white sand laminated with clay. Small iron-nodules, perhaps derived from decaying pyrites are also occasionally present. The following section will afford a notion of the nature of the beds disclosed.

1. Laminated sand and clay.
2. Pale grey, or french-white sand.
3. Bright yellow sand.
4. Pale grey or french-white pipeclay, with a carbonaceous layer on the top.
5. Hard and irregular ferruginous layer.
6. Bright yellow laminated sand, passing downwards into paler (or white) sand.

The large outlier at Baughurst is about three-quarters of a mile in size. The Lower Bagshot Beds must be of trifling thickness here, the distance between the Bracklesham Beds and the London Clay occupying a very small space on the Map. The nature of the junction-beds is well displayed in the bank forming the side of a hollow lane by the churchyard to some farm-buildings. Both there and further on in a south-easterly direction, beyond Browning Hill House, the glauconite sands make their appearance, and are seen in the road-cuttings.

The same green sands were also noticed in the smaller outlier near Bowling Green.

At the brick-yards, on the south side of Hazeley Heath, the bricks are made of a sandy clay, belonging to the lower beds of the Bracklesham Series. This clay, of the colour of coarse brown sugar, and pale glauconite-green, is underlaid by the dry Lower Bagshot Sands, which are of a drier nature and paler colour. They are very well seen in

the neighbourhood of the brick-yards, where the clay has been removed for the purpose of making bricks.

The white sands of Winchfield House, and on either side of the South-Western Railway cutting, on Shapley Heath, immediately westward of the station, after a careful examination of the ground and mature consideration, have been included in the Bracklesham series, although they might, at first sight, appear rather to belong to the overlying Upper Bagshot Sands, which make their appearance in the adjoining Map (Sheet 8) to the eastward.

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## CHAPTER VIII.

### SUPERFICIAL DEPOSITS.

#### GRAVEL.

##### *General Remarks.*

THE flint-gravel which covers a large area in the district comprised in Map 12, is of two kinds, and of different ages. The one occupying the higher grounds and the crests of the hills is the older; the other or newer gravel, probably derived in a great measure from the destruction of the high-level gravel, is found in the valleys, and may, in consequence, be called, by way of distinction, the low-level gravel. This being the case, it is evident that the denudation of the present valleys in the Chalk must have taken place at a later date than that at which the high-level gravel was deposited.

#### HIGH-LEVEL GRAVEL.

##### *Pebble-Gravel.*

Pebble-gravel, or drift-gravel composed of rounded pebbles of flint, is of rare occurrence in this district.

The topmost parts of the large Tertiary outlier S.W. of Hungerford (see p. 25), are capped by this gravel resting on the London Clay.

The crest of Pebble Hill, south of Kintbury, as has been before remarked, is covered with a deposit of rounded pebbles to the depth of at least ten feet. The pebbles are small and black, and are imbedded in a base of yellow sand. The gravel has been much worked away on the side of the road, but the nature of the deposit may be examined on the east side of the road, over the hill, from Kintbury to Pitcombe Row.

Pebble-gravel was also noticed in a lane half a mile north-east of of Inkpen, and also south-east of Balsdon; in both cases resting on Lower Bagshot Beds. In fact, it is a remarkable circumstance that this superficial pebble-gravel is nearly always found on the higher grounds in the south of England. Hence, it may be inferred that it is, over the area in question, of a different, and perhaps older date, than either the angular hill-gravel, or the valley-gravel afterwards to be described.

##### *Angular Gravel.*

The greater part of the high-level or older gravel, in the present district, is composed of subangular flints. "It overspreads the Bagshot Sands from Sulhamstead Abbots to Silchester and Silchester

" Common, and is distributed over the tops of the hills eastwards, resting on the London Clay at Spencer's Wood Common, on the Lower Bagshot Beds at Farley and Heckfield Hill, and on the Bracklesham Beds at Bramshill.

" The gravels on Finchampstead Leas and Sherfield Green also probably belong to the older drift." \*

The large outlier of the Woolwich and Reading Beds, W.N.W. of Newbury (see p. 26), is thickly covered by gravel, which stretches over the whole of the hill-top.

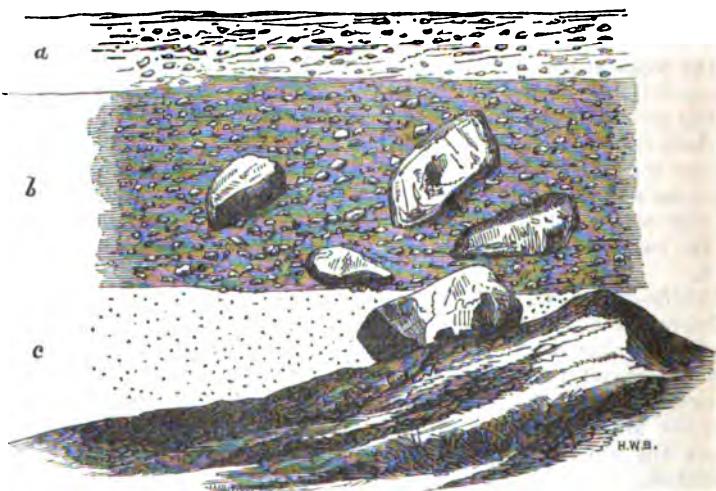
There is a thick accumulation of high-level gravel on the high grounds of Bucklebury Common, where it forms the crest of the hill capping the Lower Bagshot Beds. The same beds are also covered with a deposit of this gravel in the neighbourhood of Newbury, where they form the high grounds, as at Enborne, and the range of hills, south of Newbury, which comprise Newbury Wash and Greenham and Crookham Heaths.

The nature of the superficial gravel may be well studied in the large pits on Newbury Wash, by the side of the high road from Newbury to Pen. At the Union, south of the former town, where the broad flat plateau commences which forms the large outlier of Lower Bagshot Beds of Greenham Heath, the gravel extends to a depth of from twelve to fifteen feet.

At Enborne a flat plateau of gravel extends from the road by the church nearly to Hampstead Park House. It is about eight feet thick, and is composed of very small angular flints.

The gravel covering the Lower Bagshot Sand at the north-east corner of Inkpen Common is remarkable for the numerous blocks of greywether-sandstone, which are irregularly interspersed through it. Some of the blocks are of large size. The annexed woodcut (fig. 8)

Fig. 8.  
Gravel-pit on Inkpen Common.



a. White angular flint-gravel.

b. Brown flint-gravel, containing large blocks of greywether-sandstone.

c. Lower Bagshot Sand.

\* From the Note-book of Mr. Richard Trench.

represents the mode of occurrence of these stones in the gravel, and the manner in which the latter covers the Eocene Sands.

*Brick-Earth.*

The crests of the hills in the Chalk-district occupying the southern portion of the Map are covered with a deposit of red clay mixed with gravel, frequently filling potholes and extending to a considerable depth. From their position, appearance, and the extent of surface which these beds are spread over, they present a very strong resemblance to the lower beds of the Woolwich and Reading Series, and this similarity is rendered the more striking in consequence of their frequently furnishing a red clay, which is used for making bricks. Close examination proves, however, that these deposits are not of the same age as the true Plastic Clay, but, that they have been derived from those beds, and, have subsequently to their original deposition been re-arranged, and, probably in some cases, transported from a distance.

There is a small outlier of brick-earth on the spot marked Tangle Clumps in the Map, where red mottled sandy clay and ferruginous brown clay were formerly made into bricks. The site of the pits, is, now, however, overgrown with grass and bushes, so that the actual section is concealed from view. Apparently this deposit was much washed, and from the occurrence of angular flints interspersed throughout the mass, as well as of angular fragments of chalk, it was considered more reasonable to associate these beds with the drift rather than the Eocene period. The depth of the clay here is about forty feet.

There are, also, traces of old brick-pits in Hurstbourne Park, which have since been filled in. The clays which are based on Chalk, appear to have been mixed with flints, and like those of Tangle Clumps to belong to the age of the superficial gravel.

"At Chawton Park, by the side of the road from Chawton Park Farm to Red Hill, there are brick-pits and kilns, in the beech-wood, about south of the letter k in Park. These pits were worked (the workmen state) a hundred years ago. The present works are twenty-five years old. The brick clay is the ordinary brown brick-earth or sandy clay, mixed with angular, subangular, and rounded chalk-flints. It has been worked in an irregular manner in numerous scattered contiguous pits, and associated with the clay here and there are lumpy, irregular, stratified masses of white sand, like the shaken wrecks of true Eocene sands of the Woolwich and Reading Series. One of the men pointed out the largest mass he had ever seen, and that was not more than three or four yards across."\*

There are other old brick-pits in the eastern corner of the wood, on the south side of the road from Meadstead to Bushey Leaze. There, also, apparently, the brick-earth occurred in patches and belonged to the drift period rather than to the Lower Eocene.

The high grounds between Meadstead and Rotherfield Park are covered, more or less, with a deposit of flint-gravel mixed with red clay.

*Low-level Gravel.*

From the eastern foot of Enborne Hill an immense accumulation of drift-gravel extends all the way to Newbury. This deposit shows an appearance of arrangement, and assumes that substratified character

\* From the Note-book of Professor Ramsay.

which is so common to the gravel of the low levels over the south of England.

A well made near the lodge at the entrance to Newbury Cemetery, was sunk through twenty-four feet of gravel. A short distance south of the gates I saw some fine sand bearing a great resemblance to the sand of the Woolwich and Reading Beds; but, according to the account of the sexton, it had been taken from a lenticular layer, interstratified with the gravel, and which only extended for a short distance. At the extreme south-western corner of the Cemetery the gravel was nine or ten feet thick, and became brown and loamy, and contained fewer flints; but in no part of the ground had the bottom of the gravel ever been reached. The gravel in the Cemetery seems to consist of ferruginous-brown subangular flints, with a few rounded pebbles of black flint, the whole imbedded in a ferruginous-brown clayey base, probably here derived from the London Clay, which occupies the higher grounds towards the south, with a slope in a northerly direction.

Near the fork in the roads north of the Cemetery the thickness of the gravel was proved in sinking a well. It was found to extend to a depth of about ten feet, and to overlie the green sands of the Woolwich and Reading Beds, from which a supply of water was obtained.

In making a sewer from the above-mentioned fork in the roads to Mr. Daller's brewhouse only four feet of gravel was met with. It rested on white sand.

Opposite the Parsonage-house at Newbury, the gravel is eight or ten feet thick. At that depth a bed of clay, which threw out water, was met with, nine inches thick, and containing rounded pebbles. The base of the gravel was very irregular and uneven; and lying at the bottom were several rounded blocks of greywether-sandstone resting on the underlying green sands of the Woolwich and Reading Beds. "In a gravel-pit "on the southern side of the Kennet, nearly opposite to Woolhampton "there is in the gravel a seam of brown sandy clay, from one inch to "five inches thick, in which there are a few small pieces of carbonized "plants."\*

Around Gravel Pit Farm the superficial gravel has become hardened into conglomerate by means of a ferruginous cement, and large blocks of it are frequently turned up by the plough in the fields. This gravel, consolidated into conglomerate by an iron-cement, occurs very abundantly between Bowling Green and Pamber. It is there composed of ordinary shingle-flints, with a black flint-pebble, at rare intervals, in a ferruginous cement; the whole forming an iron, brecciated conglomerate. Some of it is of a ferruginous-brown colour; but, for the most part, the flints are white, and the iron base of a dark brown colour. The stone is found, forming large masses, in the superficial drift-gravel, in draining the land. It occurs in patches and basins, sometimes at a depth of ten feet below the natural surface of the ground, and attains a thickness of two feet and more.

On the north side of the brook at Weston there are gravel-pits on the borders of the alluvium, showing a thickness of about ten feet. This gravel is white and composed chiefly of angular and shingle-flints in a chalky base. Sometimes the gravel is very fine, and then it shows no signs of orderly arrangement or stratification. I could not learn of any bones having been found in this gravel, but a man's skull had been dug up, some years ago, from the gravel on the opposite side of the stream. The surface of the gravel is somewhat brown, and it is furrowed out into potholes filled with a browner gravel, which owes its

\* From the Note-book of Mr. Aveline.

colour to a slight admixture of brown clay washed into it from the surface of the ground. Owing to the scarcity of brown gravel in the immediate neighbourhood, the finer portions, or rather the base of this gravel, is used for making garden walks, after it has been sifted and the larger stones separated. When laid down it is puddled, and then it seems to answer the purpose very well. It is described as possessing the advantage of being able to bear the action of frost without breaking up.

There appears to be a thick deposit of angular flint-gravel in the valley between Upton Grey and Greywells (or, as it is spelt on the Ordnance Maps, Grewell) extending to the latter place. This gravel throws out springs at different points in its course, and gives rise to the Whitewater river, which after flowing in a northerly direction past Greywells, Poland, Dipley, and Holdshot Mills east of Heckfield, discharges itself into the Blackwater at Thatcher's Ford.

Accumulations of flint-drift cover the bottoms of the valleys and low grounds on the Chalk, the sides of the hills being (as is the general rule) free from gravel and composed of bare chalk. It will be impossible to mention the names of all the localities where gravel may be found, neither is it necessary; the nature of it presenting nothing worthy of special notice, and its character being nearly the same throughout the district comprised in the Map.

It may be mentioned, however, that elephants' bones and teeth have been found by Mr. Curtis in the mammalian gravel in the railway-cutting opposite the "Hen and Chickens Inn," S.E. of Froyle.

It is also worthy of notice that the inlying valley of Upper Greensand of Burghclere and Sidmorton is quite free from drift or gravel, and furnishes a remarkable instance of the complete manner in which the removal of vast thicknesses of strata has sometimes been effected by denudation, without any traces of the beds washed away being left behind in the form of gravel.

The flat country north-east of Burghfield is covered with the low-level gravel.

H. W. BRISTOW.

#### *Alluvium of the Kennet.*

The alluvium of the Kennet is a well-marked deposit, and forms large and valuable water-meadows. Besides the main stream, there is generally a network of side streamlets that distribute the water over the whole alluvial flat, and give harbourage to large numbers of water-fowl. This alluvium is of a somewhat uncommon kind, consisting of alternations of peat, clay, and, shell-marl, the last being made up, almost wholly, of broken and more or less decomposed freshwater shells of species now living. It has been described by Dr. Buckland (Trans. Geol. Soc., 2nd ser., vol. ii.) and by Mr. Rupert Jones (in a "Lecture on the Geological History of Newbury," Blacket, Newbury, 1854). Of both of these accounts I shall avail myself largely.

The peat is, in places, from 5 to 15 feet thick, and is—

"Much intermixed with minute crystals of Selenite and a small quantity of carbonate of lime, and abounds with branches and other remains of trees, viz., fir cones, nuts, and seeds, and also with the bones and horns of oxen, red deer, roebucks, horses, wild boars and beavers. A human skull of high antiquity has also been found in it, at a depth of many feet, at the contact of the peat with a substratum of shell marl. It was accompanied by rude instruments of stone. Along the northern edge of this peat-bog there is a considerable deposit of marl, mixed with calcareous tufa from 2 to 10 feet in thickness, and frequently interstratified with beds of peat, varying from 6 inches to 3 or 4 feet in thickness; its substance is, in some

parts, a soft laminated cream-coloured marl; in others it is tufaceous and granular. Throughout the substance of the marl as well as of the tufaceous beds are dispersed the same varieties of horns and bones that occur in the peat, and multitudes of shells of the same freshwater molluscs which now inhabit the adjacent river. These freshwater shells are in various stages of decay, and from this circumstance I am disposed to refer the origin of the calcareous matter of the 'strand' to the detritus of dead shells that have in former times been accumulated along the boundary line of the highest floods of the river.

The skimming of these flood waters would be composed of dead shells, and if we suppose all but the most recent of them to have undergone decomposition during the period of their lying in the 'strand,' and their calcareous materials to have been converted into the marl and tufaceous concretions of which this strand is composed, we adopt an hypothesis fully adequate to explain the phenomena.

It is quite impossible to refer the origin of the tufaceous portion of these marl beds to the action of springs or of flood waters charged with carbonate of lime.\*

The reasons given for this are that there are no springs in the neighbourhood that bring down a sufficient quantity of carbonate of lime, and that flood waters would have deposited their contents all over the flat, and not along one side only.

The mammalian remains "are usually met with in the Lower Marl, " and apparently are more plentiful towards the edge of the valley. " The following list comprises the best known of these fossils, from " the neighbourhood of Newbury :"†

<i>Bos primigenius.</i>	<i>Canis lupus</i> (Wolf).
<i>B. longifrons.</i>	<i>Lutra vulgaris</i> (Otter).
<i>Cervus capreolus</i> (Roebuck).	<i>Ursus spelaeus.</i>
<i>C. elaphus</i> (Red deer).	<i>Castor Europaeus</i> (Beaver).
<i>Equus.</i>	<i>Arvicola</i> (Water-rat).
<i>Sus scrofa</i> (Pig).	

Mr. Jones gives the following list of land and freshwater shells from the peat and shell-marl.‡

<i>Neritina fluviatilis.</i>	<i>Pupa muscorum.</i>
<i>Bithinia tentaculata.</i>	<i>P. pygmaea</i> (and var. <i>alpestris</i> ).
<i>B. Leachii.</i>	<i>Carychium minimum.</i>
<i>Valvata piscinalis.</i>	<i>Lymnaea auricularis.</i>
<i>V. cristata.</i>	<i>L. peregra.</i>
<i>Limax agrestis?</i>	<i>L. stagnalis.</i>
<i>Helix aspersa.</i>	<i>L. palustris.</i>
<i>H. hispida</i> (including <i>H. concinna</i> , a variety without hairs).	<i>L. truncatula,</i>
<i>H. nemoralis</i> (including <i>H. hor-tensis</i> ).	<i>Ancylus fluviatilis.</i>
<i>H. arbustorum.</i>	<i>A. lacustris.</i>
<i>H. pulchella.</i>	<i>Physa fontinalis.</i>
<i>H. fulva.</i>	<i>Planorbis albus.</i>
<i>H. rufescens</i>	<i>P. corneus.</i>
<i>H. sericea.</i>	<i>P. Nautilus.</i>
<i>H. virgata.</i>	<i>P. marginatus.</i>
<i>H. rotundata.</i>	<i>P. nitidus.</i>
<i>Zonites nitidulus.</i>	<i>P. spirorbis.</i>
<i>Z. alliarius.</i>	<i>P. contortus.</i>
<i>Z. radiatus.</i>	<i>P. vortex.</i>
<i>Z. crystallinus.</i>	<i>Cyclas cornea.</i>
<i>Succinea putris.</i>	<i>Pisidium amnicum.</i>
<i>S. gracilis.</i>	<i>P. pulchellum.</i>
<i>Zua lubrica.</i>	<i>P. pusillum.</i>
	<i>P. obtusale.</i>

\* From Dr. Buckland's Paper.

† Mr. Jones's Lecture, p. 40.

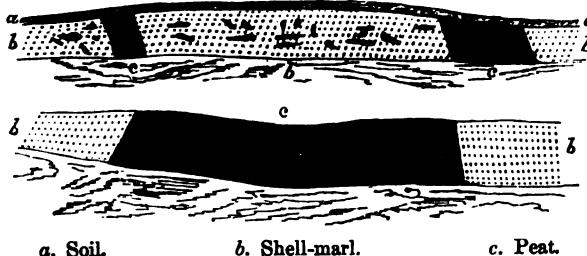
‡ In Mr. Jones's List the species are named according to Turton's Manual (1840); they are here corrected after Sowerby's "Illustrated Index of British Shells," 1859.

“Three or more species of *Cypris* and quantities of *Gyrogonites* also occur. Numerous miscellaneous articles belonging to the historic period have been met with in the peat-fields; but the exact circumstances under which they have been found, and their respective positions in the several beds, have not been carefully recorded.”\*

The peat is dug in many places for fuel. In it are found the remains of the following trees,—oak, alder, willow, fir, birch, and hazel; and of mosses, reeds and equisetum. Nearly half a mile westwards of Marsh Benham, west of Newbury, there is a section showing at two places vertical masses of peat in the midst of the shell-marl, the junction being sharply defined. See fig. 9. At another part of the section there is peat below the shell-marl.

fig. 9.

Sections in the Alluvium of the Kennet West of Newbury.



a. Soil.

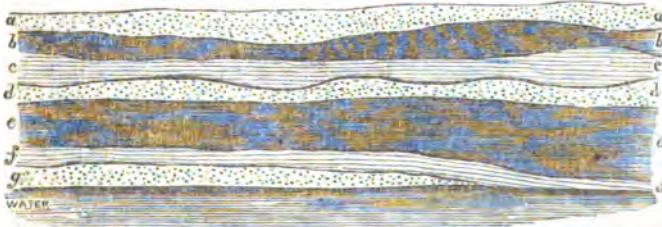
b. Shell-marl.

c. Peat.

Nearly half a mile to the south-west of Thatcham Station is a section showing alternations of peat, clay, and shell-marl (fig. 10). There is probably more peat beneath the water. It has been largely dug away in this neighbourhood.

fig. 10.

Section in the Alluvium of the Kennet, S.W. of Thatcham Station.



a. Shell-marl -	}	FT. IN.
b. Peat - - -		3 6
c. Peaty clay - - -		
d. Shell-marl - - -		
e. Peat - - - 1 ft. 6 in. to - - -		2 8
f. Brown clay with broken shells - - -		0 8
g. Shell-marl - - -		

To the west of Woolhampton station there is a section nearly 200 paces in length, and from 5 to 6 feet deep, chiefly in shell-marl; but showing also layers of peat and peaty clay, which run through the whole length of the section, and, in parts, a light-coloured clay full of

\* Mr. Jones's Lecture, p. 42.

shells. The beds are flat, but slightly waved. In some places the marl is coloured and partly cemented by sesquioxide of iron ; in others it is hardened into masses of loose friable tuff, sometimes made up almost wholly of small tubes, many of which have an internal diameter not larger than that of a fine needle.

The alluvium rests on the low-level gravel. At the eastern corner of the sheet the flat formed by the latter has been mapped in with the alluvium. It having been thought advisable, some time after this district was surveyed, to map that gravel all along the course of the Thames valley, &c. ; and as here it hides the boundary-line of the London Clay for some distance, and is moreover very difficult to divide from the alluvium (the flat being almost unbroken from the river to the rise of the London Clay), it was found convenient to include it. It is not unlikely, however, that at Hartley Court, to the east of Burghfield, it extends farther southwards than is shown on the Map.

W. WHITAKER.

The peat of the town of Newbury varies in depth from four to seven feet, and extends, in a southerly direction, about a hundred yards beyond the church. The ashes of the peat, applied as a top-dressing to the land, have been used with great success as a fertiliser. The quantity usually put on an acre of young clover is fifteen or twenty bushels. The price at Newbury is about fourpence the bushel. The principal cause of the good effects of the peat-ashes, on green crops and clover-leys, is, most probably, the quantity of gypsum which they contain. These ashes have been analyzed by Sir Humphrey Davy, and found to be composed of—

Oxide of iron	-	-	-	-	-	-	48
Gypsum (sulphate of lime)	-	-	-	-	-	-	32
"Muriate" (chloride of potassium) and sulphate of potash	-	-	-	-	-	-	20
							—
							100

(See Penny Cyclopædia ; Art. Berkshire.)

About two feet in thickness of the loose tufaceous deposit called *malm* overlies the peat. It is a calcareous tufa of a greyish-white colour, and contains numerous shells of land- and freshwater snails of existing species.

In the town of Newbury, in sinking a well at some new houses opposite the chapel in Northbrook Street, trunks of trees, six or eight inches in diameter, were found in a bed of peat, at a depth of seven feet below the surface ; and at fifteen feet the calcareous deposit called *malm* were met with containing land- and freshwater snails of existing species.

There is a very fine specimen of the cranium and horns of *Bos primigenius*, measuring three feet between the tips of the horns, in the Museum of the Newbury Institution. It was dug out of the peat in Ham Marsh some years ago, about six feet below the surface, and near what appeared to be an old road, and when found was enveloped in the decayed boughs of trees, amongst which the hazel could be identified.

Spear-heads and other objects have been found in the peat on Speen Moor ; and the upper part or scalp of a human skull has been met with deep in the peat, in the same ground from which some spear-heads had been obtained at Speen.\* No other bones were dis-

\* Speen was a Roman station, *Spinæ*, and one of the principal scenes of action in the second battle of Newbury, fought in October 1644, between the troops of Charles I. and those of the Parliament.

covered near, except some teeth exactly corresponding in size and character with those that are in the head of the ox before alluded to.

Great quantities of willows are grown in the river-flats between Thatcham and Woolhampton, and are cut every year for basket-making.

*Greywethers.*

Blocks of hard sandstone, conglomerate and grit, which are known by the name of *Greywethers*,\* *Sarsen Stones*, or *Druid Stones*, are not uncommon in this district. They are frequently made use of to keep vehicles from running against the banks by the roadside, or against the corners of houses.

Some of these stones are used for such purposes at Thatcham, one of which must have occupied its present place for a considerable time, having received a polish from the constant use of it as a seat by the village children.

“ By the side of the road, west of Holly Wood, N.N.W. of Thatcham, there are some conglomerate-stones. These were grubbed up in the wood when it was being cut down. I was told that some of great size had been found, and that they were taken up nearly in one line.”†

The Nymph or Imp Stone (marked on the Map close to the north side of the county-boundary), is a small block of Greywether-sandstone about a foot square, lying on the gravel ‡ of Silchester Common.

There are a couple of Greywethers composed of rounded flint-pebbles and angular flints imbedded in a base of ferruginous grit by the side of the road from Odiham to South Warnborough, about a couple of hundred yards beyond the four cross-roads.

Some masses of pudding-stone have been before noted (p. 26) as occurring at Standen Farm, near Hungerford.

H. W. BRISTOW.

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\* See Descriptive Catalogue of Rock Specimens in the Museum of Practical Geology, 2nd edition, pp. 288 to 290. Also Survey Memoirs on the Geology of Map 34 p. 41, and of Map 13, p. 47.

† From the Note-book of Mr. Aveline.

‡ See Memoir on “The Woolwich and Reading Series,” by J. Prestwich, F.R.S., in Quart. Journ. Geol. Soc. vol. x. p. 124 (foot-note).





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SE. Part of Warwickshire.

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